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Journal of Electricity

Devoted to the Economic Production and Commercial Application of Electricity
IN THE ELEVEN WESTERN STATES

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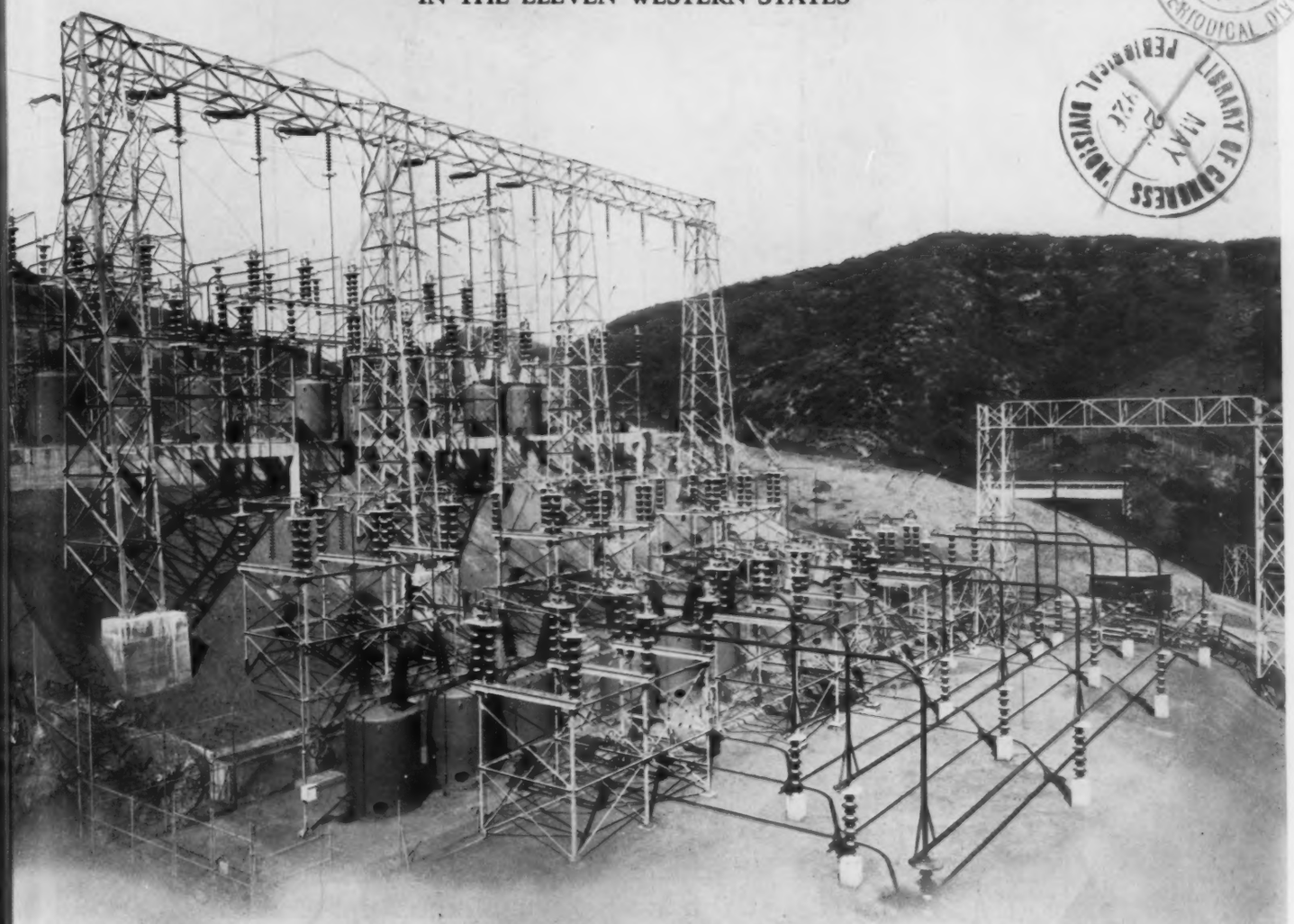

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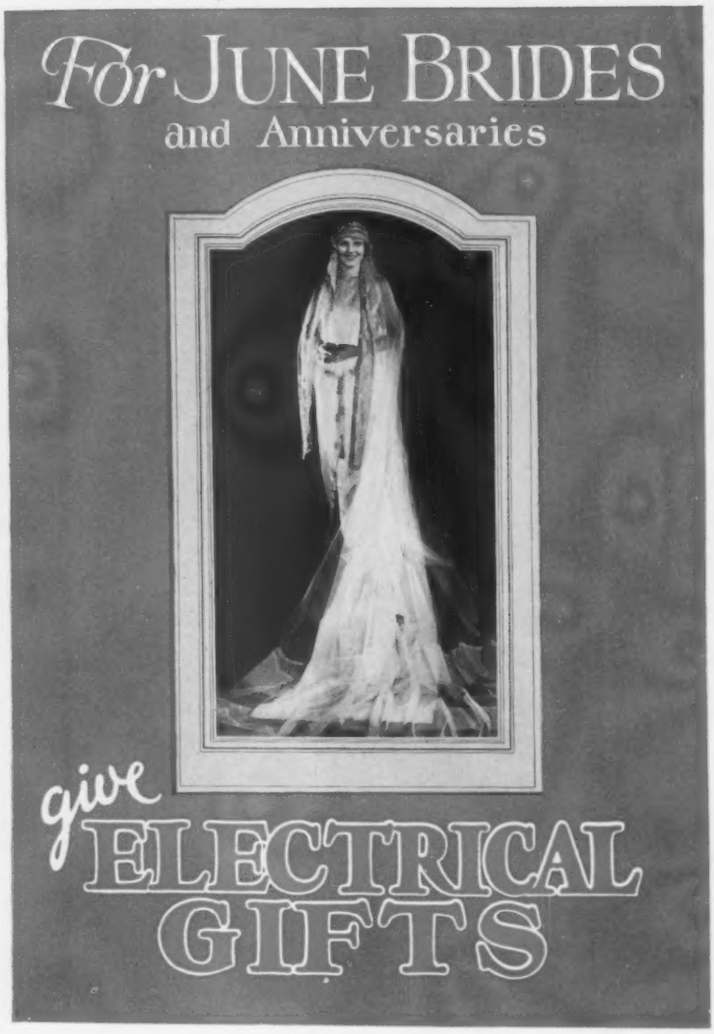

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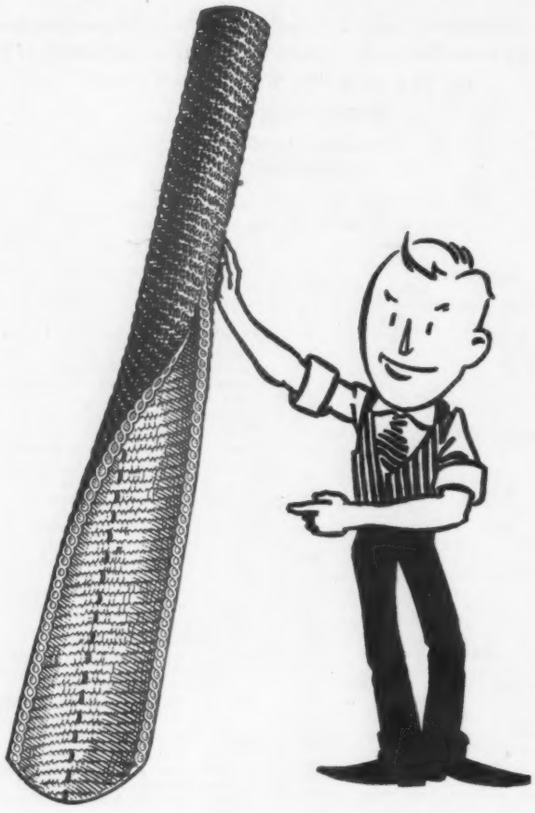

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EDITORIAL

Year's Progress Recorded in Committee Reports of P. C. E. A.

COMMITTEE reports to be presented at the tenth annual convention of the Pacific Coast Electrical Association at the Biltmore Hotel, Los Angeles, June 8-11, 1926, comprise the major portion of the editorial section of this issue of the Journal of Electricity.

THESE papers cover a wide range of subjects and present an accurate cross-section of the most advanced practices and problems incident to the generation and application of electrical energy to the service of the community. Discussions range from the design of a modern substation or the burning of fuel oil and natural gas under boilers to the application of electricity to heating water or providing refrigeration in the home. They represent the year's work of committees of specialists who have given generously of their time and effort so that all may benefit from the experiences of each individual.

LOGICALLY the discussions center about the central station as the hub of the wheel representing the electrical industry. Nevertheless there is much in the reports which has a definite bearing upon every branch of applied electricity. Every man in the industry will benefit by a careful perusal of those phases of the reports which bear upon his particular field.

THE practice of publishing the papers prior to the convention has been adopted because it affords an opportunity to all members of the association to study the reports carefully so that they may be prepared to enter fully into the convention discussions. Moreover, it brings the convention to those who are so unfortunate as to be unable to attend. Again, it affords all readers of the Journal an opportunity of participating to this extent in the benefits of membership in the association.

THOSE who have had the privilege of reviewing the papers unanimously agree that they represent the finest effort in the history of the association. It behooves every reader to devote as much time as possible to the study of these reports. Only by so doing will he fit himself to keep pace with the most rapidly progressing industry in the country.

LOS ANGELES, convention city of the Pacific Coast Electrical Association, June 8-11, as it appears from the air. Here delegates from Pacific Coast territory will hear the story of the year's development in the arts of electricity.

—Rogers Airport Photo.

"Each May Draw the Total Sum Without Diminishing the Principal"

By William A. Baurhyte

President, Pacific Coast Electrical Association

WHEN you come to the 1926 convention of the Pacific Coast Electrical Association in Los Angeles in June, be prepared to do two things:

1—Give

2—Take

It is a mistake if any delegate thinks that because he is not on the program nor on a committee he is not in position to add to the interest or value of the convention. For he is.

The chief value of a convention is in the getting together of the leaders in the industry, where each contributes his enthusiasm, his experience and his friendship to an inexhaustible fund, wherefrom each may draw the total sum without in the slightest diminishing the principal.

WILLIAM A. BAURHYTE

A convention is not like a bank. A bank depositor may withdraw his own, with its accrual, but no more. And no one else may touch it.

A convention is different. Each delegate is gainer to the extent to which he has taken for his own use of the contributions of the others and is richer by just so much as he has given of his own personality and experience to the edification of his fellow delegates.

In other words, a convention is all gains and no losses!

While all these benefits are conferred by any good convention, the forthcoming P.C.E.A. convention on June 7 to 11 will have a special theme in the prosperity of the territory served by the association. The program will carry through the idea of security to investment and business and the constant improvement and extension of electrical service.

The usual study of group problems through the section meetings has been provided for. At the same time care has been taken to see that the various phases of the industry are treated liberally in the program for the general sessions so that all who attend the convention may get a fairly complete picture of the electrical situation in the territory of the Pacific Coast Electrical Association.

Special effort has been made to foresee and satisfy the social needs of the gathering, as well as the purely business features. A round of pleasure has been scheduled for the ladies. People who play golf will find that facilities are at hand to satisfy the craving for golfing. Banquet, reception and ball will minister to the happiness of those who like a dash of evening entertainment to season the more serious activities of the convention sessions. In its entirety, it is the desire and earnest endeavor to make this convention a well rounded, sanely balanced meeting of the people of the electrical industry of this geographic division. There will be no fads, no eccentricities. It will be just a convention. We hope and believe it will be a very good convention and very enjoyable. We plan to sound the note of sanity in business and business relations and in business control and regulation.

Each section of our association has added to the knowledge of our craft by the work it has accomplished during the year. It will be our privilege to hear of these accomplishments and to discuss their significance during the sessions of the convention. The importance of these works to the world we serve as public servants will depend in a measure upon the thought and study we give them.

We urge and invite the executives and leaders of the industry to attend and to see that as far as possible those who would profit from the convention attend also.

And come bearing the gift of your own contribution to the fund of knowledge and good-will so that the harvest may be the greater for us all.

Technical Section Reports

Electrical Apparatus Committee Reports*

Outline of Year's Work

By J. C. GAYLORD

It is impossible at this time to give a complete report of the activities of the apparatus committee as all the studies started have not yet been completed. This, while complete in some respects, will be more of a progress than a final report.

The electrical apparatus committee this year is carrying on the work of keeping in touch with new developments and uses of electrical apparatus, especially as applying to the operating companies of the Pacific Coast. It also is making special studies of the operation of oil circuit breakers in service of relays and relay applications and of Pacific Coast practice in substation design. In conjunction with the overhead systems committee and the safety rules committee the committee is studying fuses, transformer voltages and ratios and electrical grounds. In conjunction with the inductive co-ordination committee it is studying remote supervisory control, especially its application to substations.

At each meeting considerable time also has been given to the discussion of operating experiences. These discussions proved very interesting and instructive.

In addition to the above work, which is carried on within our own territory, the committee is co-operating with the electrical apparatus committee of the N.E.L.A. by gathering data and by answering many questionnaires sent out by subcommittees of the national committee.

Organization

This year the committee has some 60 members representing the member operating companies of the P.C.E.A., the manufacturers and manufacturers' agents. The general organization is on the company-correspondent plan although special committees have been appointed by the chairman for the study of particular subjects. The company-correspondent plan was chosen with the hope that each correspondent might have within his company a small apparatus committee, if you please, to study the general program as it applies to his particular system. In this way the benefits of the work are participated in by the largest number. This scheme of organization has proved very satisfactory and the interest shown in the meetings has been enthusiastic. The personnel of the committee is shown in the accompanying list.

Meetings and Program

A total of three double meetings have been held this year; in Los Angeles on Sept. 24 and 25, 1925, at which there was an attendance of about 65; in San Francisco on Jan. 14 and 15, 1926, at which the attendance was about the same; and in Fresno April 8 and 9, 1925, with an attendance of about 70.

One of the sessions of the Los Angeles meeting was devoted to illustrated talks on substation design as practiced by the Pacific Gas and Electric Company, the Southern California Edison Company, and the San Diego Consolidated Gas and Electric Company.

The first talk was given by S. J. Lisberger of the Pacific Gas and Electric Company in which he described the designs used by his company for city and for rural substations. H. L. Sampson and G. A. Fleming described a small standard distribution substation and a typical transmission substation as designed by the engineers of the Southern California Edison Company. K. B. Ayres described a noiseless downtown station built by the San Diego Consolidated Gas & Electric Company. All three papers brought forth much discussion.

At the San Francisco meeting the substation designs submitted by different operating companies were discussed. A preliminary report of the subcommittee on oil circuit breakers presented by R. C. Denny of the San Joaquin Light & Power Corporation also aroused interest and discussion.

C. E. Schnell of the San Joaquin Light & Power Corporation presented a paper, illustrated with lantern slides, entitled Some Notes on Substation Design as practiced by his company. L. A. Buese of the Los Angeles Gas & Electric Corporation presented an illustrated talk on the East Side substation of that company. Both papers were very interesting and brought forth considerable discussion.

R. R. Cowles, chairman of the Technical Section, P.C.E.A., who represented our apparatus committee at the Detroit meeting of the national apparatus committee gave a short report of that meeting and presented an illustrated paper on the Wallenpaupek 220-kv. power project of the Pennsylvania Power & Light Company, which had been presented at the Detroit meeting. This paper was discussed by Walter Dreyer and E. A. Crellin of the Pacific Gas and Electric Company and proved very interesting.

A joint session also was held with the overhead systems committee and the safety rules committee for the discussion of the preliminary reports of the subcommittee on fuses, on transformer voltages and ratios, and of the subcommittee on electrical grounds.

Committee Reports

Relays and relay applications, oil circuit breakers, electrical grounds, and a series of reports on substation design on the Pacific Coast will be found on the following pages. These reports represent the work completed, or brought to a state of partial completion warranting a report, within the past administrative year.

Fuses and transformer voltages and ratios, and remote supervisory control are covered in joint committee reports submitted respectively under the overhead systems committee and the inductive co-ordination committee. The chairmen of these joint committees were appointed from these two major committees, thus the reports appear accordingly.

---

* **J. C. Gaylord,** Southern California Edison Company, chairman; **H. A. Laidlaw,** Pacific Gas and Electric Company, vice-chairman. **Allis-Chalmers Company:** F. H. Searight. **California Oregon Power Company:** S. M. Bullis, R. M. Daniels, H. A. Fraser. **C. E. Ingals, Inc.:** C. E. Ingals. **Coast Counties Gas & Electric Company:** W. R. Van Bokkelen. **Coast Valleys Gas & Electric Company:** G. A. Peers, T. W. Snell. **Delta-Star Electric Company:** W. W. Kirk. **Garland-Affolter Engineering Company:** P. H. Affolter, G. E. Armstrong, A. E. Garland. **General Electric Company:** M. S. Barnes, J. H. Cunningham, H. E. Fuqua, W. E. Melarkey, M. H. Schnapp, W. C. Smith, J. S. Spurck, H. C. Stanley, E. E. Valk,. **Great Western Power Company:** C. F. Benham, R. P. Crippen, G. K. Morrison, A. Scott. **Los Angeles Bureau Power & Light:** M. O. Bolser, H. H. Cox, C. H. Jenkins, O. Wingard. **Los Angeles Gas & Electric Corporation:** F. E. Dellinger, C. B. Judson, F. R. Knight, G. A. Riley. **Ontario Power Company:** A. J. Hall. **Pacific Electric Manufacturing Company:** J. C. Clark. **Pacific Gas and Electric Company:** E. A. Crellin, B. D. Dexter, R. B. Kellogg, H. A. Laidlaw, H. S. Lane, S. J. Lisberger, H. T. Sutcliffe, J. O. Tobey, Roy Wilkins. **San Diego Consolidated Gas & Electric Company:** K. B. Ayres, A. S. Glasgow, D. J. Kelly, E. D. Sherwin, C. W. Wiggins. **Southern California Edison Company:** L. H. Beebe, L. L. Dyer, G. A. Fleming, D. J. Kenneley, C. C. Long, H. L. Sampson, E. R. Stauffacher, F. H. Mayer. **City of San Francisco:** P. J. Ost. **San Joaquin Light & Power Corporation:** R. C. Denny, H. N. Kalb, H. H. Minor, L. J. Moore, C. E. Schnell. **The Southern Sierras Power Company:** R. H. Halpenny, J. N. Keith, D. K. Lawson, P. H. Yelton. **Westinghouse Electric & Manufacturing Company:** J. E. Brown, A. W. Copley, W. F. Grimes, R. A. Hopkins, W. P. L'Hommedieu, R. C. Stackhouse, W. L. Winter. **H. B. Squires Company:** S. P. Russell.

Addenda: Great Western Power Company: G. H. Hager. **Los Angeles Gas & Electric Corporation:** L. A. Buese. **Southern California Telephone Company:** G. R. Nott.

Program for 1925-1926

At the Los Angeles meeting the following program for the year's work received final approval. Following its adoption there was considerable discussion of the subjects therein.

1. Pacific Coast practice in transmission and distribution substations; this should be the major topic.
2. Tests of station grounds; further information on this subject is very desirable.
3. Oil circuit breakers:
   (a) Report of any tests which may be conducted by Pacific Coast companies.
   (b) Gather data and study oil circuit breaker operation by a special committee in conjunction with the member companies in the use of form adopted by the Apparatus Bureau at Fresno meeting, 1925.
4. Review of transformer voltages in conjunction with the overhead systems committee.
5. Relays and relay application:
   (a) New types of relays for the protection of transmission networks.
   (b) New types of relays for the protection of internal trouble in equipment.
   (c) New or unusual application of older types of relays.
6. Lightning arresters.
7. High-tension fuses.

Pacific Coast Practices in Transmission and Distribution Substation Design*

Palm Springs Substation, The Southern Sierras Power Company; 15/2.3-kv. Distribution

By P. H. YELTON

This substation was built to take care of increased load at Palm Springs, a rapidly growing desert winter resort. The old 2-pole 75-kva. substation is continued in operation to carry increased load south and east of the town. The outdoor structure is of the standard pipe-frame construction frequently used for distribution substations. The station is unattended; the local agent reads meters and gives what other attention is required. Eventually the local agent's office and dwelling will be located on the substation lot.

I. 15 kv.

(a) Frame work and general layout: The frame work is of 1½-in. galvanized iron pipe construction, each panel diagonally braced with ¼-in. galvanized steel strand. One bay is provided for each trans-

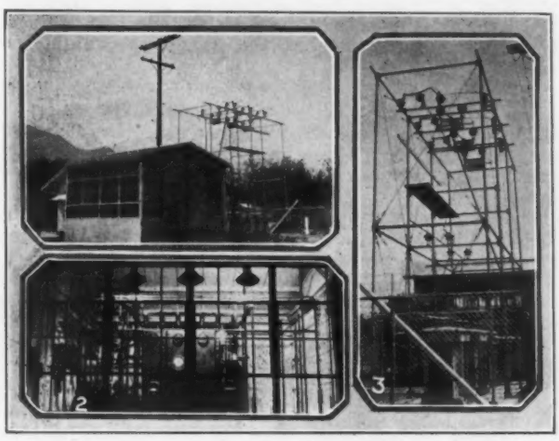


Fig. 1. (1) Showing station building, transformer rack, and two outgoing 2.3-kv. circuits. (2) Night view through windows of station. (3) Close-up of transformer rack.

former and provision is made in the design of the ultimate layout for two incoming 15-kv. circuits. Lines are carried to the structure with a slack span from the dead-end pole at the corner of the lot.

Only one 15-kv. circuit is brought into the substation at this time and it may be noted from Fig. 1 that the arrangement shown in Fig. 2 was not followed exactly. It was thought better to bring the one circuit into the structure in a symmetrical manner; also by this arrangement the necessity for a bus was avoided at this time.

(b) Transformers—Three 100-kva., single-phase, 15/2.4-kv., self-cooled, Westinghouse type SK.

(c) Air-break switch—Three-pole, 27-kv., 100-amp. air-break switch assembled by S. S. P. Company.

Disconnect switches — Fused disconnect switches, S. S. P. Company design.

(d) Electrical protection — Westinghouse 17-kv., auto-valve lightning arresters are connected on the sta-

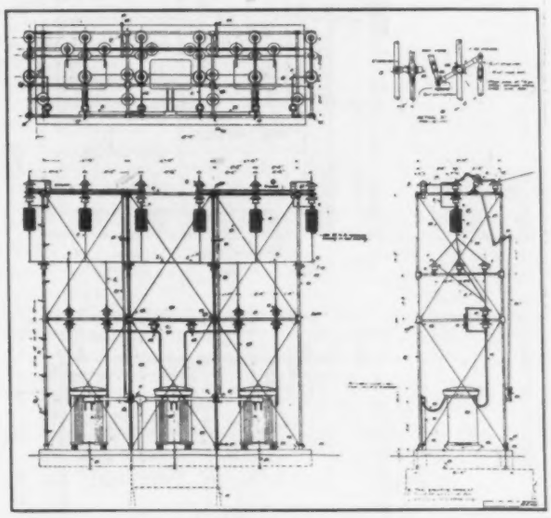


Fig. 2. Details of transformer rack.

tion side of the air-break switches. Pacific Electric 17-kv., 30-amp. fuses are used in the transformer disconnect switches.

II. 2,200 Volt

(a) Frame work and general layout—The 2,,300-volt construction is located indoors and is mounted on 1¼-in. pipe framework.

(b) Induction regulators—Two single-phase, 23-kva., G.E. type I.R.S. regulators with 10 per cent regulation are connected in the transformer mains to

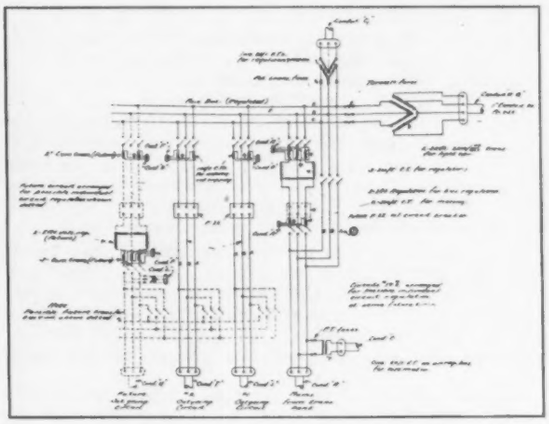


Fig. 3. Three-line wiring diagram; all dotted lines indicate future equipment.

the bus, providing regulation for the entire station. Provision is made for possible future installation of regulators on all feeder circuits.

(c) Switching equipment—The two outgoing 2.3-kv. feeders each are equipped with a 400-amp., 7.5-kv. Westinghouse type F-22, hand-operated, remote-control, oil circuit breaker. Provision is made for a future oil circuit breaker on the 2.3-kv. mains from the transformer.

*General report, Electrical Apparatus Committee; comprising information gathered from various member companies.

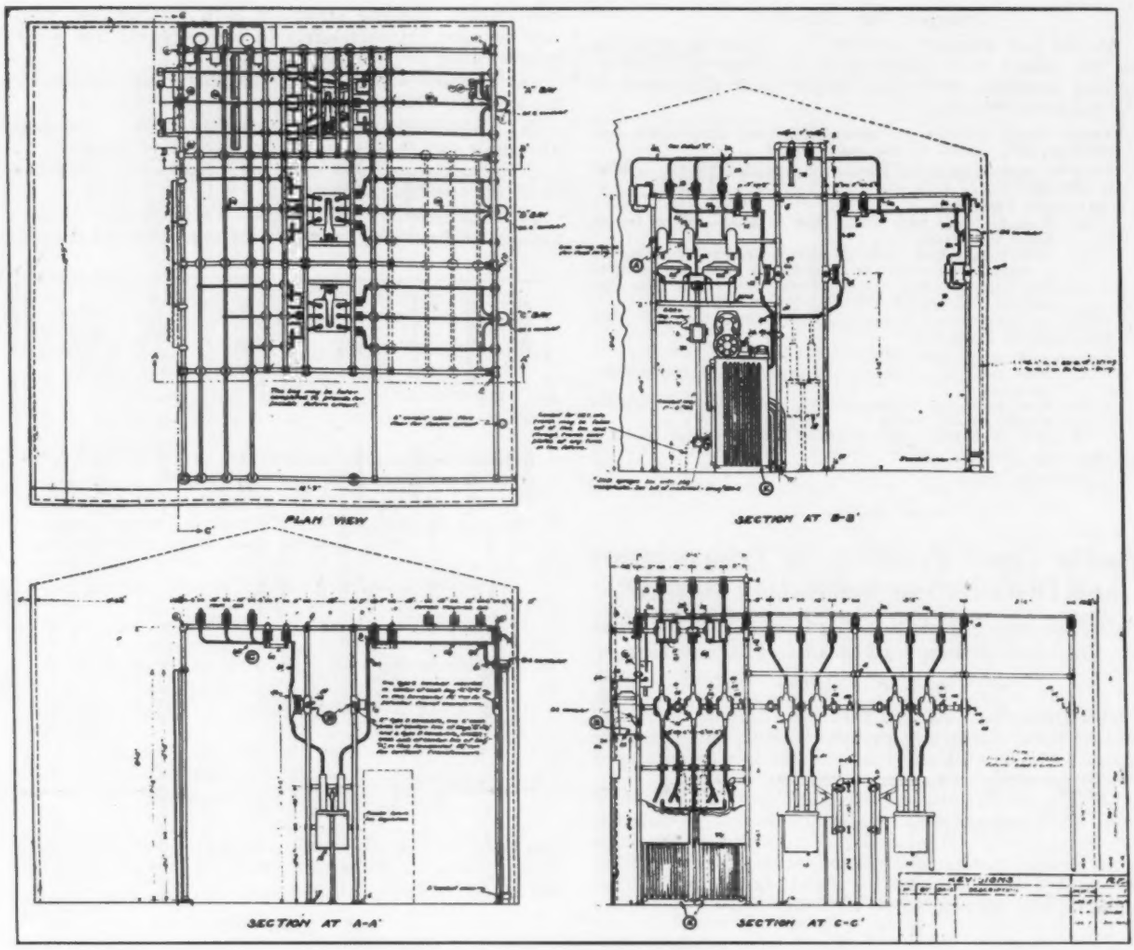


Fig. 4. General arrangements of equipment within the station.

(d) Electrical protection — The 2,300-volt circuit breakers are equipped with inverse time limit trip coils. Provision has been made for installing overload relays if found desirable in the future. There are no lightning arresters on the outgoing feeders.

(e) Switchboard and metering—Three black marine slate panels 16x65x2 in. in dimension with three 16x25x2-in. sub panels are used for the 2.3-kv. circuits. These are placed together with space for a future panel. One totaling panel is provided for the 2.3-kv. mains from the transformer and provision is made for placing an oil switch on this panel as mentioned above. Two panels are provided for the two 2.3-kv. feeders and the plans provide for the addition of a third feeder panel when needed.

A watthour meter is provided on the totaling panel, indicating ammeters on each panel, and a Bristol recording voltmeter on the regulator bus. A bracket indicating voltmeter with a voltmeter switch makes it possible to read voltage on one phase of the unregulated bus and each of the phases of the regulated bus.

Station service — Two 3-kva. 2,200/220-110-volt transformers connected open delta are provided for station service, lighting and induction-regulator motors. These are protected by Line Material Co. P46C5 throttle fuses rated 4.4 kv. with 3-amp. fuses.

(g) Lines—All 2.3-kv. circuits are 6.6-kv. varnished-cambric, single-conductor cable run from the building in underground iron conduit to the first pole from the station.

(h) Building — The substation building is steel angle frame construction about 16x16x12 ft. in dimension, with concrete floor and foundation. The sides are covered with No. 16 gage and the roof with No. 24 gage galvanized sheet steel. Steel window sash was used freely in the construction of the building to improve the appearance and to increase the lighting. A certain advertising effect is gained also in the appearance of the building at night as shown in Fig. 2.

(i) Miscellaneous electrical equipment—Each set of 15-kv. lightning arresters is connected by No. 1/0 stranded bare copper wire run down the pipe frame to two Paragon ground cones interconnected with the same size conductor. Two other separate cones are provided, one for grounding the transformer cases and 15-kv. pipe frame work and one for grounding the building, conduits and 2.3-kv. frame work in the building.

The transformers and 15-kv. bus structure are surrounded by a 7-ft. steel chain-link fence. The ultimate design provides for the erection of a building and landscaping so that the grounds will be in keeping with the development of the surrounding neighborhood.

Coronado Substation, San Diego Consolidated Gas & Electric Company; 2.3-kv. Distribution

By K. B. AYRES

This is a distribution substation for switching and regulating purposes only, fed at the same voltage which is distributed from it. The station is located across San Diego bay from the generating stations and is fed by two submarine cables each approximately 3,600 ft. long laid across the narrow point in the bay and operated in parallel.

Supplying these cables is a feeder direct from Station A, with an emergency connection through pole-type, non-automatic oil circuit breakers so that either or both may be supplied from either the Coronado

Fig. 1. General view of the Coronado substation.

feeder or from the emergency. The substation ends of the cables are brought to the same panel, each equipped with an oil circuit breaker. All equipment is indoors and all circuits to and from the station are run underground to cable poles.

Switchboard panels are of natural black slate, the panel and subbase being 72 in. high. Disconnecting switches are mounted on separate panels above the main board, with the bottom hinge 8 ft. above the floor.

The bus is split with bus disconnects so that the regulator is connected between the incoming feeders and the distribution mains. Oil circuit breakers so arranged and interlocked that an instantaneous change from regulated to unregulated service can be made. The station light and power, and series street-lighting circuits are fed from the unregulated end of the bus and all the distribution mains from the regulated end. Station light and power is furnished by a very small open-delta transformer bank, as the requirements are very light.

Oil circuit breakers are 4.5 kv., type K-5, with a capacity of 200 amp. They are manually operated and equipped with automatic trip. There is one 2.3-kv., 3-phase, 250-amp. regulator installed. Feeder characteristics are very similar so that separate regulation is not required.

Street lighting service is supplied by one 60-kw., type RV constant-current transformer controlled on the primary side by a 2.3 kv. time switch. The alarm system is connected to a klaxon horn outside the station in the court so that it is readily heard any place on the property and in the operator's house.

The substation building is of brick, stuccoed. The architecture of both the substation and the operator's home is Mission style with a wall inclosing the yard and extending between the station and the house forming a court. On the rear of the lot is a double garage with a work shop and a storage room.

As there is no subway system near this station the cables are carried in ducts running directly to the cable poles from a cable trough or pit back of the switchboard.

This station serves the whole of the city of Coronado, with a population of 4,000 inhabitants, and the Army and Navy aviation fields with their quarters and shops on North Island.

Alta Vista Substation, San Joaquin Light & Power Corporation; 11/2.3 kv. Station

By C. E. SCHNELL and E. K. SADLER

This substation is one of three 11/2.3-kv. zone substations on an 11-kv. loop circuit in the city of Fresno. Both ends of the 11-kv. loop come from the California Avenue substation. A large part of the city of Fresno is served by 2.3-kv. distribution lines and it was to take care of growing needs of the city that these zone substations were built. At each of the zone substations are two line switches, one for each side of the loop, protected by directional relays so that trouble

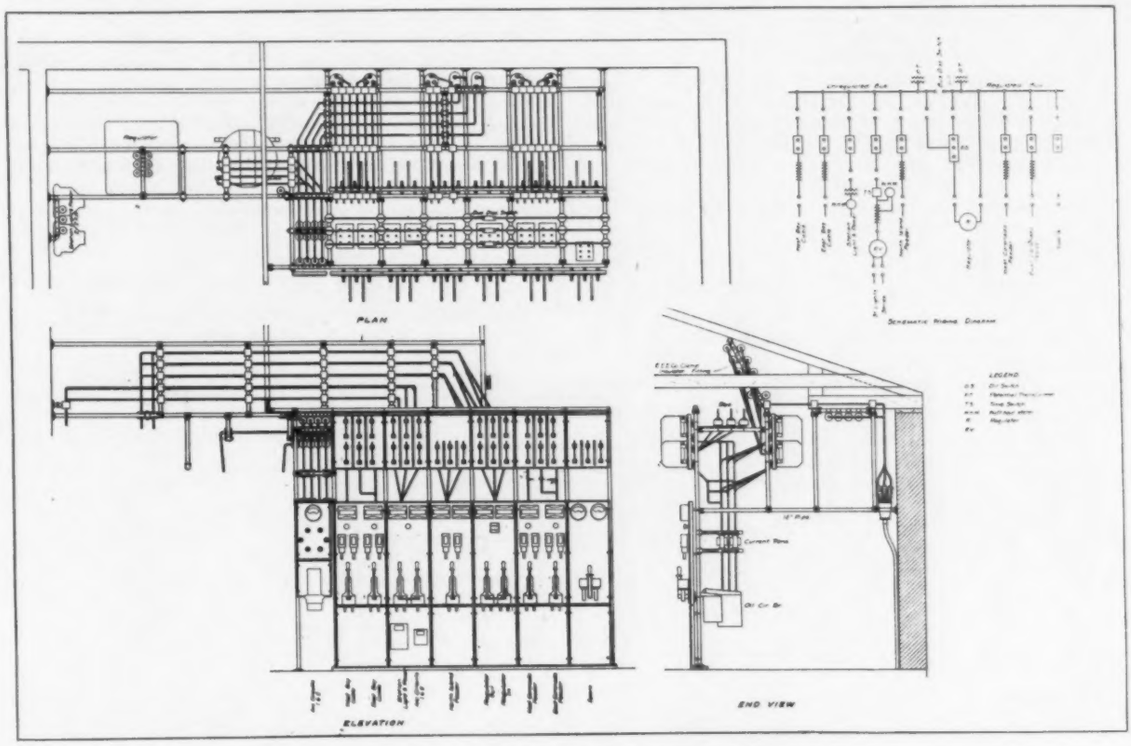


Fig. 2. Schematic wiring diagram, Coronado substation.

at one point on the 11-kv. loop will not interrupt service to the substations. There are four feeder switches installed and spare locations for four more.

At Alta Vista the 11-kv. and 2.3-kv. structures were built as a unit; the 11-kv. switches being on one end and the 2.3-kv. on the other end of a single pipe rack. The whole layout is outdoors except for the relays

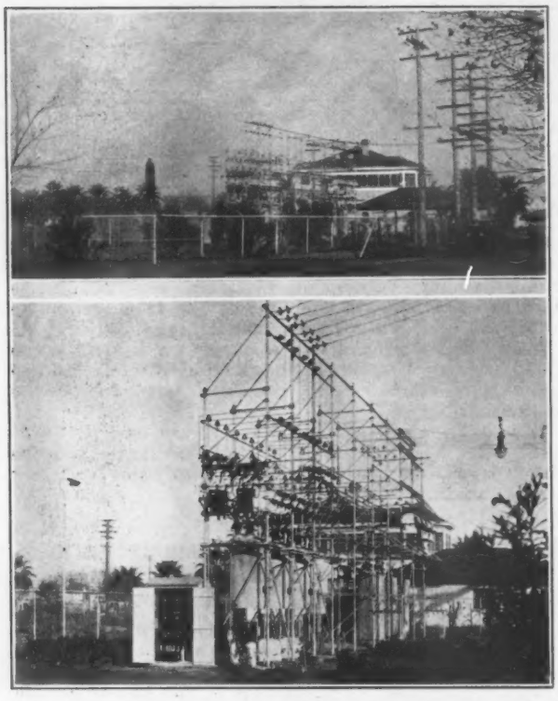


Fig. 1. General view of Alta Vista "zone" substation (above) and a close-up of the pipe bus structure and the relay house (below).

and storage battery which are in a small building. The installed capacity of the station is 1,500 kva. One spare transformer is provided for each two of this type of stations. There is no operator employed at the zone substations.

Transmission

(a) Framework and general layout—The 11-kv. switches, air and oil, are mounted on a rack built of galvanized iron pipe. There are three circuit breakers hung from the rack, two of which are line switches and the other a transformer switch. Disconnect switches provide for the bypassing of any circuit breaker. All buses are of copper tubing supported on outdoor-type bus supports. Two potential transformers hung on one end of the rack furnish potential for the CR relays. No metering is done at the zone substations.

(b) Transformers—There are three Moloney self-cooled transformers of 500-kva. capacity. Their full voltage rating is: primary, 12.5 kv., with full capacity taps; and secondary, 2.3 kv.

(c) Switches—The three circuit breakers are Kelman F-6, 6-break, 400-amp., 15-kv., manually operated and are equipped with bushing-type current transformers.

All disconnect switches are Pacific Electric 300-amp., 1,500-volt, underslung. They are mounted at about 30 deg. with the vertical for ease of operation.

(d) Electrical protection—CR directional and CO overload relays protect the line switches and CO overload relays also protect the transformer switch.

(e) Switchboard and metering—The protective relays are mounted on an ebony asbestos panel inside a small house. On the panel is also a blocking switch for each set of relays.

Distribution

(a) General layout—The 2.3-kv. rack is a unit with the 11-kv. rack. The 11-kv. bus extends the full length of the structure. The transformers are connected to the bus through disconnecting switches. A 2.3-kv. transformer bus runs over the top of the induction regulators. Two single-phase induction regulators are connected between the transformer bus and the main, or regulated 2.3-kv. bus. Disconnecting switches provide ample means for bypassing the regulators. Pole-top type automatic oil circuit breakers are used for feeder switches. These are connected to the main 2.3-kv. bus through disconnect switches. Handles for the manual operation of the feeder switches are grouped at each end of the 2.3-kv. structure. Switch operating mechanisms are connected to these handles by means of galvanized wire ropes.

(b) Induction regulators—There are two single-phase G.E. outdoor-type 2.3-kv., 69-kva. induction regulators installed for regulating the main 2.3-kv. bus.

(c) Switching equipment—All feeder switches are Kelman type 10-UA, 300-amp., 15-kv. automatic. All disconnect switches are Pacific Electric, underslung, 300- and 600-amp., 15-kv. Series trip equipment protects all feeder switches.

(d) Station service—A 5-kva. transformer hung on the 11-kv. end of the rack and connected through primary cutouts furnishes lighting service for the station. Two 3-kva. transformers connected through primary cutouts to the 2.3-kv. transformer bus supply power for the induction regulator motors, while two 3-kva. transformers connected to the 2.3-kv. main, or

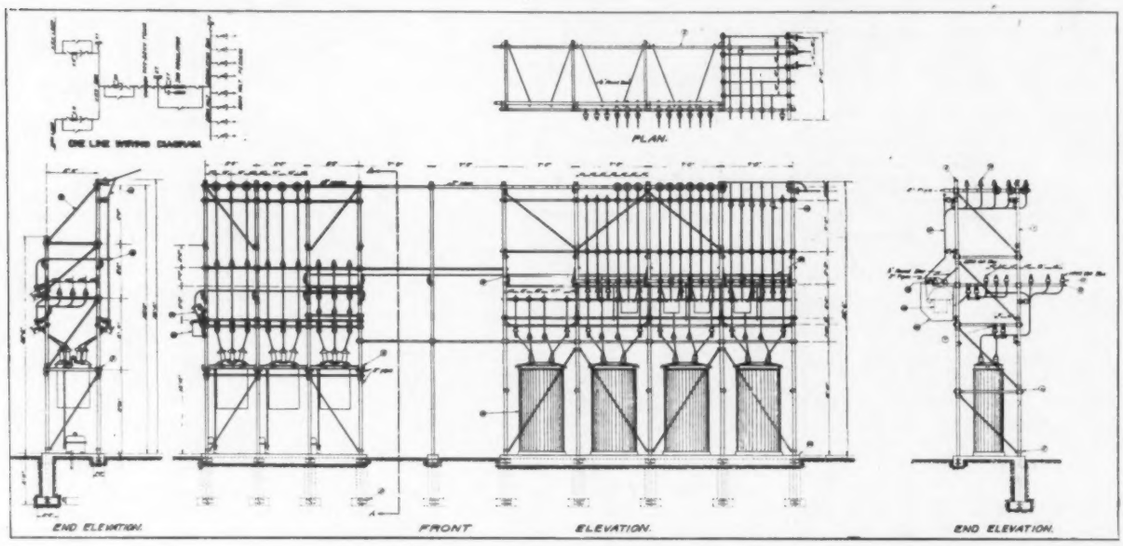


Fig. 2. Details of bus and switch structure, Alta Vista substation.

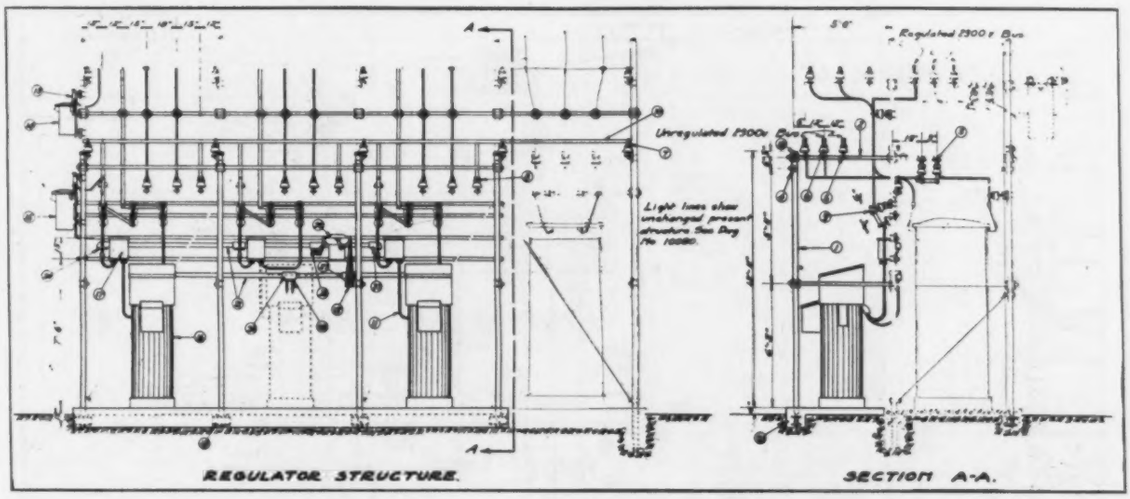


Fig. 3. Induction-regulator bus, Alta Vista substation. This is located adjacent to the transformer bus as may be seen in Fig. 1.

regulated, bus supply potential for the contact-making voltmeters on the regulators.

Miscellaneous

(a) Substation—The only building is a small 3x5x 7-ft. wood frame corrugated iron house for the relay panel and storage battery.

(b) Battery and charger—A 12-volt, 80-amp.-hr. storage battery supplies power for tripping the 11-kv. switches. There is no charger, the battery being changed as needed.

(c) Ground system—A 12-in. bore was put down 14 ft. for a ground well. A No. 3/0 wire with a copper plate attached was lowered to the bottom of the hole and the well then filled with charcoal and salt. One line of the 2.3-kv. delta bus is connected to the ground wire. All switch tanks, transformer tanks, regulator cases, and steel structures also are connected by No. 3/0 wires to the ground system.

(d) Lighting system—Outdoor reflectors mounted on pipe standards illuminate the switch structure.

(e) Conduit and underground system—All current leads, trip wires, and potential leads are in conduit placed underground.

(f) Water supply—The water supply is obtained from the city mains.

(g) Station premises—The whole yard is graded and walks are graveled. A 7-ft. Cyclone fence with barbed wire on top encloses the substation site. The portion of the substation yard that is not taken up by the pipe rack, building and walks is laid off in lawns and flower beds.

Le Grand Substation, San Joaquin Light & Power Corporation; 110/70/11 kv.

By C. E. SCHNELL and E. K. SADLER

This substation is of the outdoor-type of construction now practically standard for stations of this class. It is located on the 110-kv. line as originally built between Kerckhoff power house and Merced. The construction of the Exchequer power house of the Merced Irrigation District resulted in the Le Grand substation being chosen as the point of delivery of this power into the San Joaquin system; the entire output from the Exchequer power house is under contract to be delivered to the San Joaquin system.

There are three 110-kv. lines: Kerckhoff, Exchequer and Merced; a bank of four 5,000-kv. auto transformers, 110/70-11 kv.; one 70-kv. line to the Dairyland substation and the 70-kv. system beyond; and four 11-kv. feeders serving the local territory. All oil switches are remotely controlled from the switchboard by a 12-volt d.c. control circuit and are operated by compressed air.

Two operators are employed at this station, one or the other being on shift at all times. The company has constructed a cottage and garage for each. Both cottages are equipped with electric range, water heater and numerous convenience outlets.

Transmission

(a) Steel towers and buses—Galvanized steel towers support the buses which are No. 3/0 bare stranded copper. Where possible it has been the practice of this company to use individual towers with buses supported between, giving a much more open switch yard than is possible where a continuous steel structure type of construction is used. A transfer or auxiliary bus making it possible to tie any of the 110-kv. lines together for line-switch inspection or other maintenance work, is a very desirable feature of this layout.

(b) Transformers—There are four 5,000-kva., G.E. air-cooled auto transformers, connected Y on the high voltage side with auto-transformer connection and auxiliary connection. The tertiary is connected delta. The auxiliary winding is rated at 2,500 kva. Full winding voltages are as follows:

High voltage	63.5/110 kv., Y
Auto transformer connection	44.8/79.4 kv., Y
Auxiliary	7.2/12.5 kv., Y
Tertiary	6.6 kv.

Nominal transmission voltages are 110 kv. and 70 kv. Distribution voltage is 11 kv.

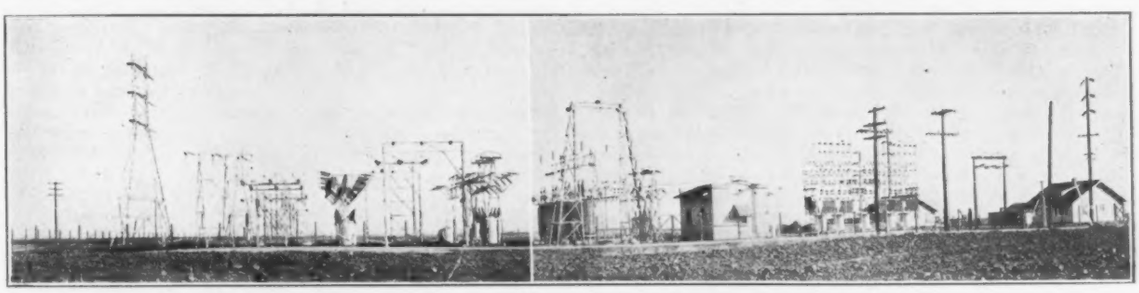


Fig. 1. General view of the Le Grand substation of the San Joaquin Light & Power Corporation.

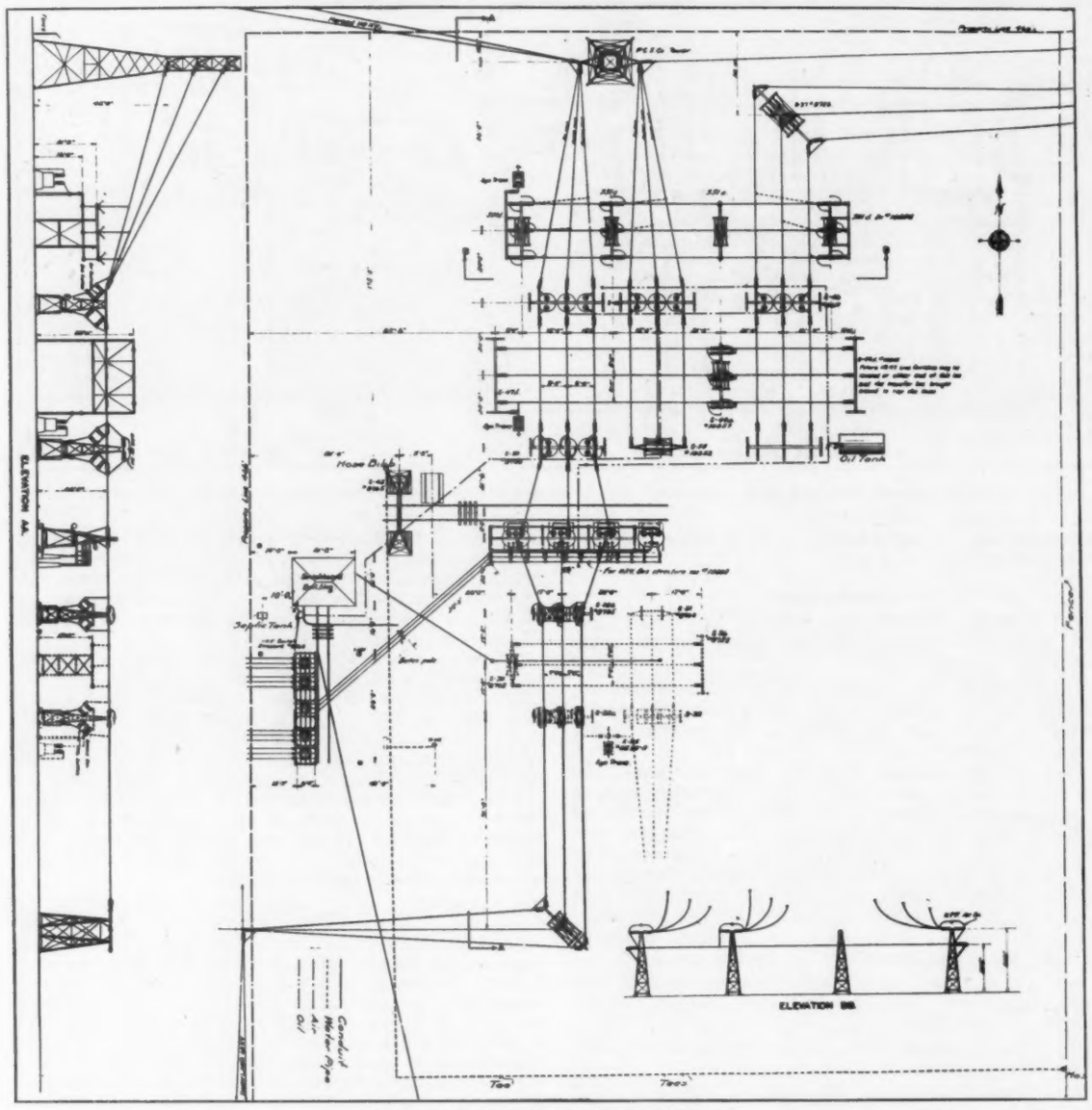


Fig. 2. Yard layout at Le Grand substation.

(c) Circuit breakers, pole top switches, disconnecting switches—All 110-kv. circuit breakers are Kelman, 4-break, round-tank, air-operated. The 60-kv. oil circuit breaker also is Kelman, 60-kv., 4-break, air-operated. All high-tension air-switches are K.P.F. type and the high-tension disconnect and ground switches are of S.J.L.& P. manufacture. Disconnect switches operate separately and ground switches operate in gangs.

(d) Electrical protection—CR-directional and overload relays are used on all line switches: CV voltage relays also are used. CO relays differentially connected protect the transformer bank.

(e) Switchboard and metering—The switchboard is made up of ebony asbestos panels and arranged with remote-control push and pull-button switches, with indicating lamps, for all circuit breakers. The switchboard is installed in the station building as a unit with the low tension board. Ammeters with 3-phase ammeter switches are installed for each line and for each 110 and 70-kv. transformer position. Current for these is obtained from bushing-type transformers in the circuit breaker tanks. Ammeters were calibrated on job. Potential and synchronizing receptacles and plugs are installed on the switchboard along with a swinging bracket carrying the synchroscope and two voltmeters. Potential of any incoming line can be measured at any time.

Distribution

(a) General layout—The feeder rack is outdoor-type, built of galvanized pipe and supports all buses, switching and metering equipment for the master switch and four feeder switches. The oil switches are mounted on trucks with a transfer track running the length of the rack and into the substation building where a pit is provided to allow lowering of the switch tanks to obtain access to the switch mechanism. The outdoor rack carries a main bus and a transfer bus. All circuits are provided with disconnect switches to allow the bypassing of any circuit breaker or the connection of any line to the transfer bus.

(b) Switching equipment—Oil circuit breakers are Kelman type F-6, 400-amp., 15-kv., truck-mounted and air operated. Disconnecting-type terminal boxes are provided for all current and control leads, which allows removal of a circuit breaker without disconnecting any wires except the main 11-kv. tubing from the bushings on top of the switch itself. All disconnecting switches are mounted at an angle of 30 deg. with vertical to provide easy operation. They are separately operated.

(c) Electrical protection—The master switch is protected by three CO overload relays Y-connected to 3 bushing-type current transformers. All feeder switches are protected by two CO relays Z-connected to 3 bushing-type current transformers.

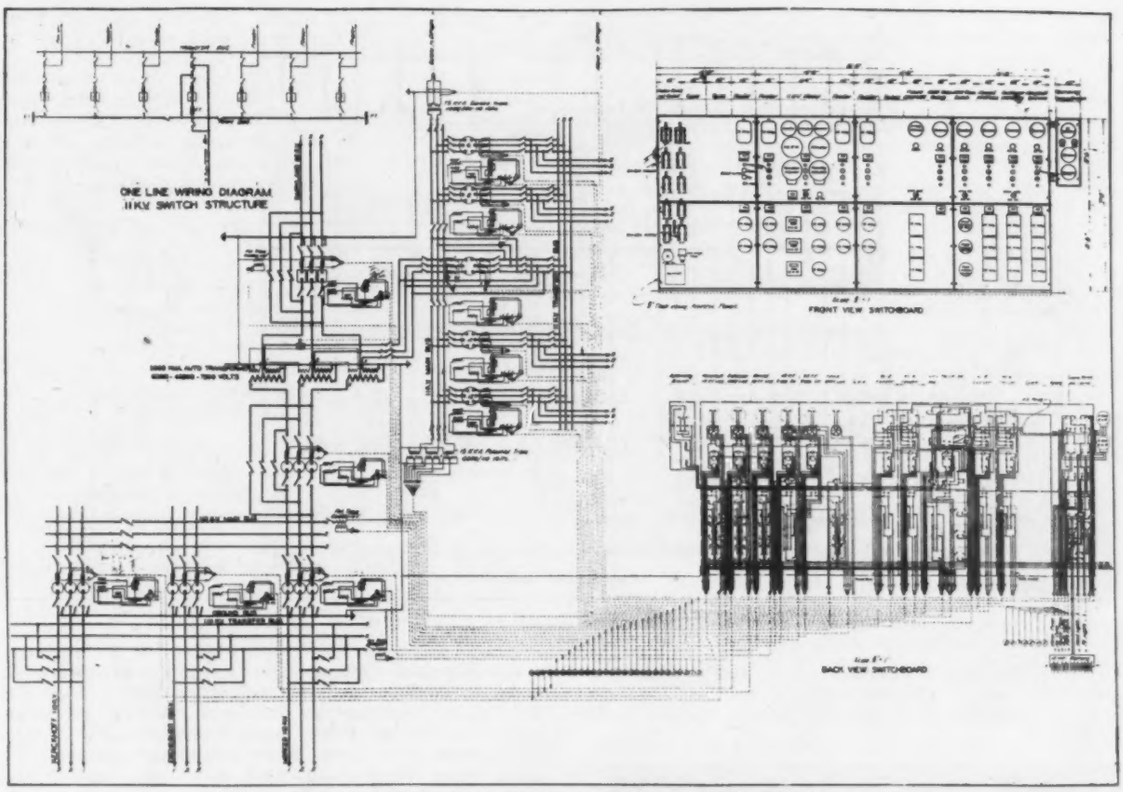


Fig. 3. General wiring diagrams for the Le Grand substation.

(d) Switchboard and metering—The switchboard is inside a brick building the exterior of which is cement-plaster finished.

Buildings

(a) Substation—The only building in the substation proper is the one which houses the switchboard, battery, telephone and other such equipment. This building is of red brick covered inside and out with cement plaster. The roof is finished with red crushed brick. Windows are steel sash. Outside dimensions of the building are 16x21 ft.

(b) Auxiliary buildings—The pump, a hydropneumatic type, motor-driven and equipped with an automatic pressure switch is housed in a pump pit and roofed over a short way above the ground level. A large pressure tank is mounted horizontally near the pump pit. This tank is covered with a roof finished with red crushed brick.

(c) Operators' cottages and garages—There are two operators' cottages and two garages, constructed of wood on a concrete foundation. Exteriors are finished with redwood siding and shingled roofs; cottages are plaster finished within. Both cottages are equipped with electric ranges, water heaters and air heaters.

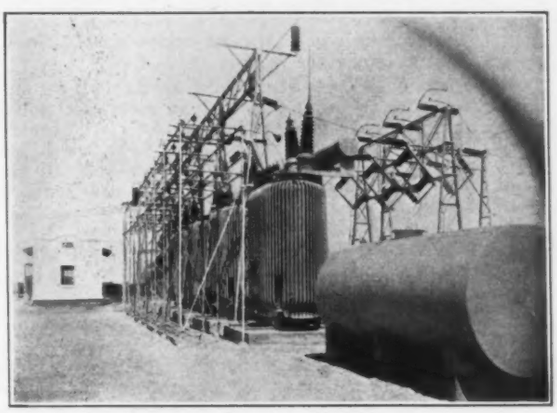


Fig. 4. Auto-transformers, transformer bus, oil-storage tank, and substation building, Le Grand substation.

Miscellaneous Electrical Equipment

(a) Battery and charger—A 12-volt, 80-amp-hr. storage battery supplies power for tripping all circuit

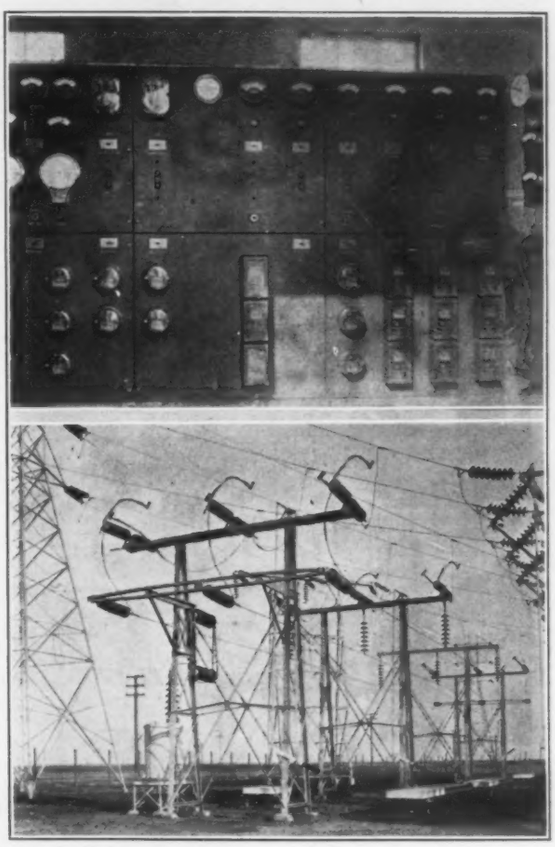


Fig. 5. Switchboard (above) and 110-kv. transfer bus (below), Le Grand substation.

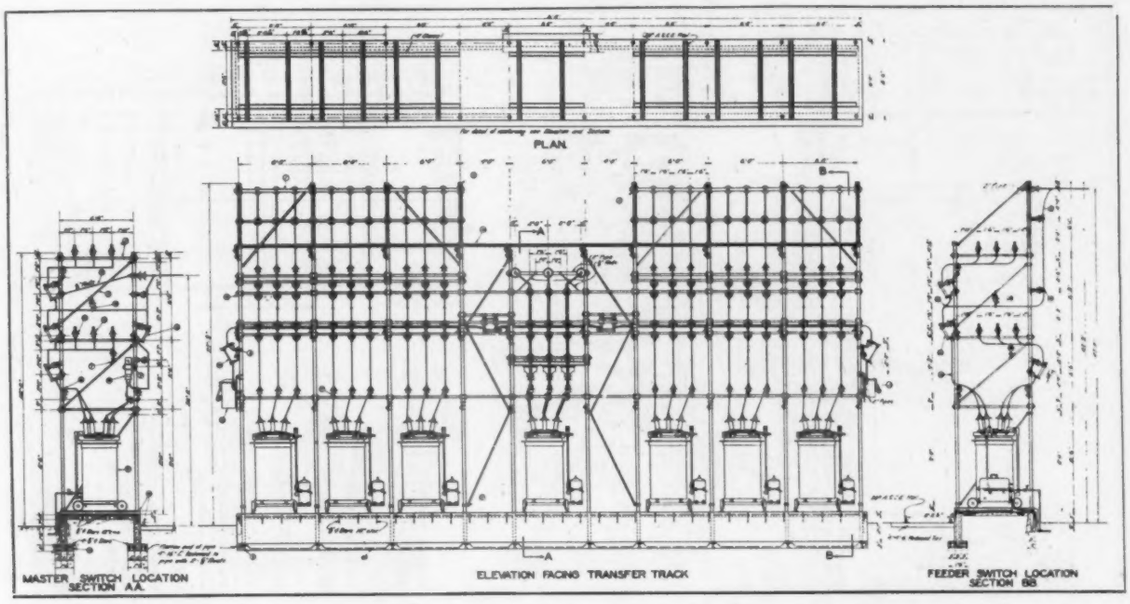


Fig. 6. 11-kv. outdoor switch structure, Le Grand substation. See Fig. 3 for wiring diagram of 11-kv. bus.

breakers, lighting indicating lamps, and operating air valves on switch closing mechanisms. A Tungar charger furnishes a continuous trickle charge to the battery.

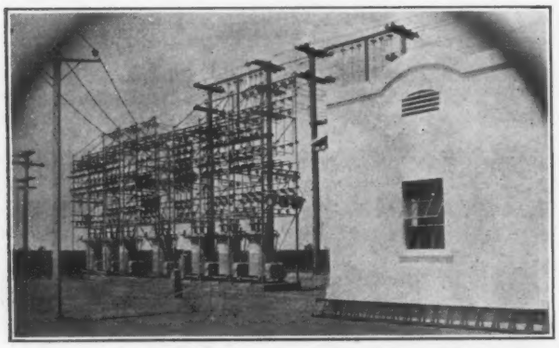


Fig. 7. 11-kv. switch structure; station building at the right, Le Grand substation.

(b) Telephones—A telephone is installed in the substation building; there are no phones in the cottages. An auxiliary gong for the phone is mounted on one of the steel poles in the switch yard.

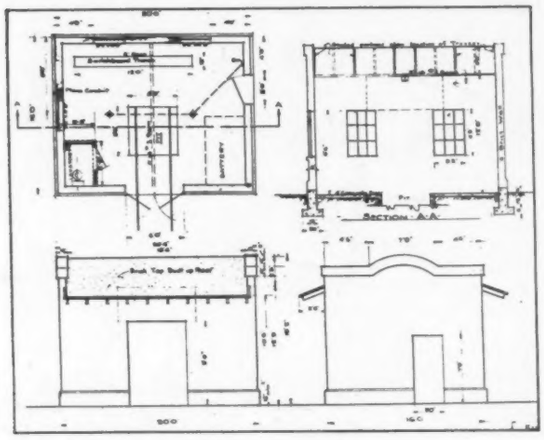


Fig. 8. General details of the station building, arranged to house only the switchboard, meters, battery and such equipment, Le Grand substation.

(c) Ground system—Two ground wells were put down at opposite ends of the switch yard. Each well was 12-in. bore and 20 ft. deep. A 2-in. galvanized pipe was driven down another foot, which brought the bottom of it 3 ft. below the water surface. The holes then were filled with fine sand and gravel. Ground lead of No. 3/0 stranded copper wire run to all steel structures, ground switches, transformer neutrals, oil switch tanks and transformer cases. Connection was made between ground wire and steel frames by means of bolts and heavy brass and copper lugs. The whole ground system was tied together and to the ground-well pipes.

(d) Alarm system—The tripping of all high-tension circuit breakers and the 11-kv. master switch energizes a 12-volt, d.c. alarm bus and sounds the alarm

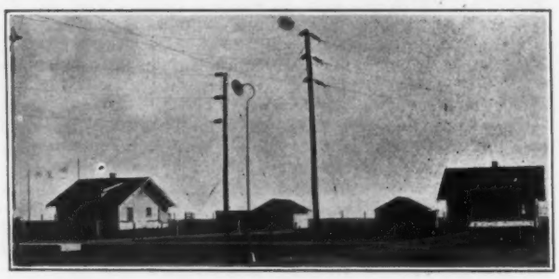


Fig. 9. Cottages and garages, Le Grand substation.

gong. The locking out of the SS relays on the feeder switches also rings the alarm.

(e) Lighting—The switch yard is lighted by outdoor-type reflector units mounted at accessible points on structures and on pipe standards. All control wires, current leads, potential leads, light wires and station power wires were run underground in galvanized conduit. All conduits also are connected to the ground system.

Miscellaneous Mechanical and Structural Equipment

(a) Water supply—The water supply is obtained from a well in the substation yard.

(b) Oil storage and filtering system—An oil storage tank of 3,750-gal. capacity is located in the switch yard. This tank provides enough capacity to allow the draining of any oil switch or transformer at the substation. Oil lines of 1½-in. pipe are run to positions near all switches and transformers to allow the connection of hoses from the oil pump and filter. The

oil pump and filter are portable equipment, not kept at the substation permanently.

(c) Air system—A motor-driven single-stage air compressor with automatic pressure switch maintains a pressure of 120 lb. in all air lines and in two pressure tanks, one located near the 11-kv. circuit breakers and the other located centrally with respect to the high-tension circuit breakers. The air compressor is installed in the substation building. Connections from the air compressor to the pressure tanks are of 1-in. pipe. Lines to the 11-kv. switches from the pressure tanks also are 1-in. while from pressure tank to the high-tension switches are 1½ and 2-in. lines.

(d) Miscellaneous—The ground around the substation yard and cottages was graded and leveled, and walks and driveways covered with gravel. Seven-ft. wire fence on wood posts encloses the property.

There are three septic tanks installed at the substation. One each to take care of the sewage disposal from the substation building and from each operator's cottage.

In the substation building there are two 1-qt. Pyrene extinguishers. In each operator's cottage there are two 3-gal. extinguishers. In one of the operator's garages is located one 3-gal. extinguisher.

Henrietta Substation, San Joaquin Light & Power Corporation; 70 kv. and 11 kv.

By C. E. SCHNELL and E. K. SADLER

Henrietta substation, located on the west side of the San Joaquin Valley, is one of the older stations on the San Joaquin system. It is an important 70-kv. switching station and also has considerable load on the 11-kv. distribution lines which furnish power for irrigation pumping. Transformers and part of the high-tension switching equipment as well as all 11-kv. circuit breakers were inside of a steel-frame hy-rib building, until the first part of 1925. Part of the high-tension equipment was on wood-pole structures outdoors. The 70-kv. oil circuit breakers were of too small capacity and had blown up on several occasions. The 70/11-kv. transformer capacity was too small and the wood-pole outdoor construction obsolete so the station was rebuilt in 1925.

A new outdoor switch yard was constructed using all-steel galvanized structures which are standard with this company. Switch, dead ends, transfer bus towers, etc., all are separate units spaced so as to give good clearance for all buses. There are 5 70-kv. lines at the substations, Kearney, Corcoran, Tulare Lake, and Coast, the latter being a tie with the Midland Counties Public Service Corporation. The Coast line is metered at 70 kv. at this station. The new 70-kv. bus is of No. 3/0 stranded copper. A transfer or auxiliary bus runs in front of all the line switches allowing the tying together of any lines outside of the main bus. This transfer bus also provides a means for bypassing the line switches for inspection and repair. The main bus is provided with an air sectionalizing switch. Two potential transformers, one on the main bus and one on the transfer bus, are provided for synchronizing. An 11-kv. transfer rack built of galvanized pipe was constructed outside the substation building. New 11-kv. feeder switches were installed inside the building. Only one operator is employed at this substation.

Transmission

(a) Framework and general layout—The high-tension switch yard is of the open type outdoor construction now standard with this company. Separate galvanized steel structures are spaced so as to give good clearance and to support all buses, air switches, ground switch and disconnect switches. Transformers are mounted on concrete blocks under the 70-kv. transformer bus. All high-tension oil switches are mounted on separate framework under the switch towers and the layout is such that all circuit breakers can be bypassed to allow inspection and repair work.

(b) Transformers — General Electric 1,500-kva., self cooled; full-winding voltage rating; primary voltage, 40.1/69.5 kv. Y with full capacity taps; secondary voltage 7/12.1 kv. Y with full capacity taps; tertiary

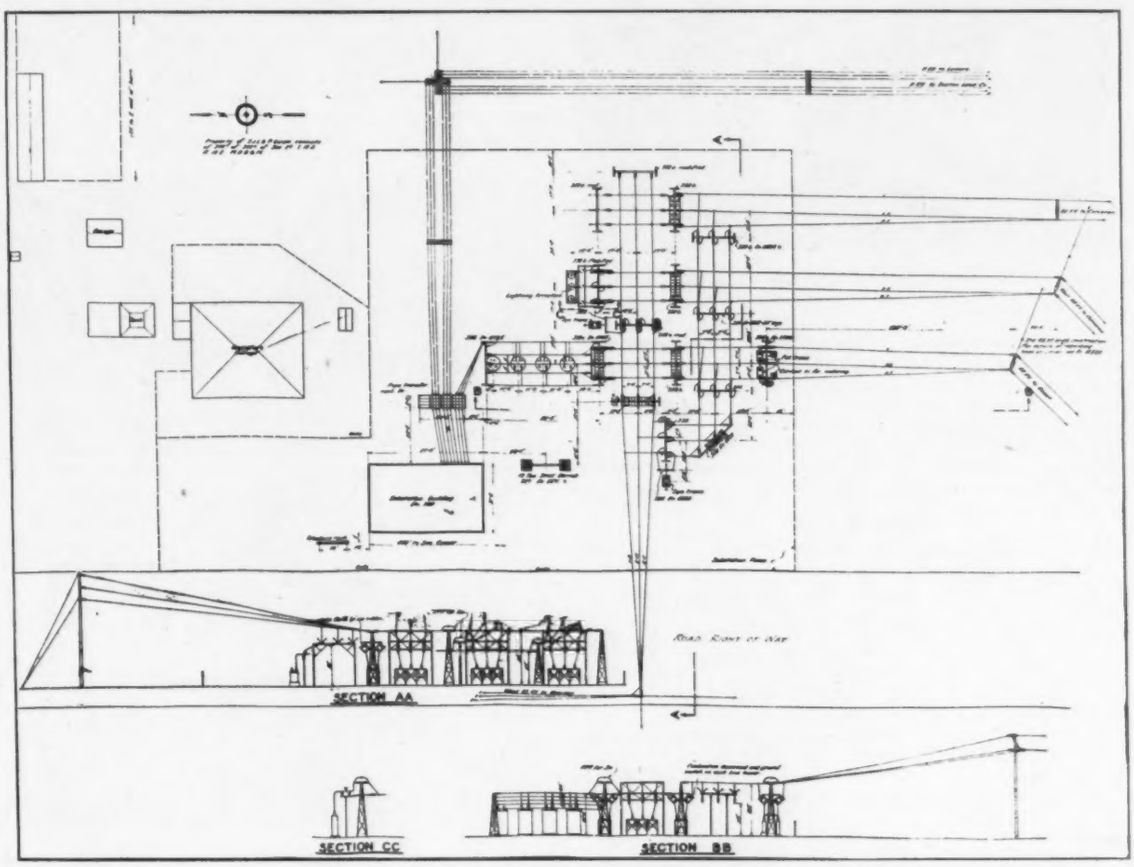


Fig. 1. Yard arrangements, Henrietta substation.

(300 kva) 2.3 kv. Nominal transmission voltage is 70 kv.

(c) Switches—The four 60-kv. line circuit breakers and the 60-kv. transformer switch are Kelman 60-kv., 300-amp., 4-break oil circuit breakers, manually operated. All air switches are K.P.F., all ground and disconnect switches are of S.J.L. & P. manufacture. Disconnect switches are underslung and mounted at 45 deg. with post-type insulators. The ground switches are unit with the disconnect switches, being mounted on the same channel base.

(d) Electrical protection—All the line switches and the transformer switch are automatic. CR directional and overload relays protect all line switches; protection for the transformer switch is series trip.

(e) Switchboard and metering—All protecting relays are mounted on a switchboard inside the substation building. Potential and current transformers are mounted under a steel tower on the Coast 70-kv. line for metering the Midland Counties load from this point. The metering instruments are on a panel inside the substation building and consist of 2 ratchet polyphase watthour meters, one indicating wattmeter, one graphic center-zero wattmeter and two ammeters.

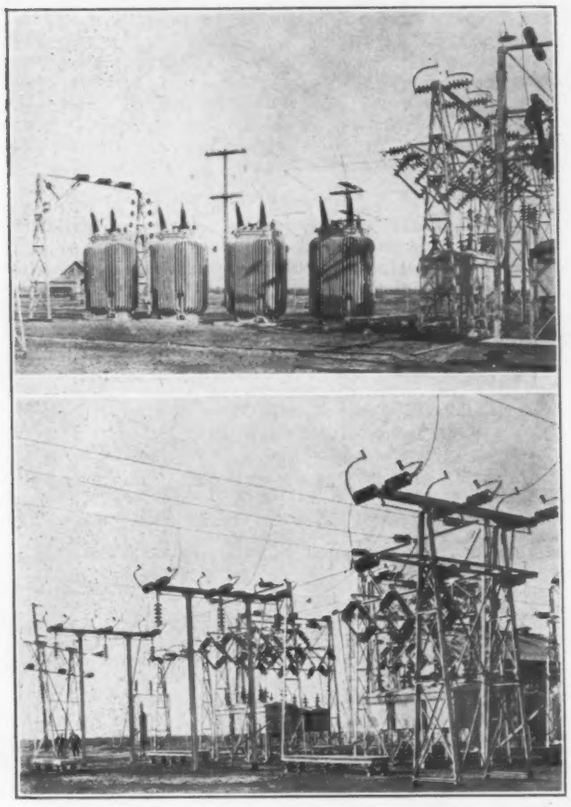


Fig. 2. 70/11-kv. transformer bank (above) and 70-kv. transfer bus (below), Henrietta substation.

Distribution

(a) General layout—The distribution voltage at the station is maintained around 12 kv. There are two feeder lines from the station with a spare switch installed for a third feeder. Master switch and feeder switches are inside the substation building. A transfer rack outside the building provides for the bypassing of any of the circuit breakers. This rack is of galvanized iron pipe construction.

(b) Switching equipment—The master switch is a G.E. K-12 oil circuit breaker and is non-automatic; feeder switches are Condit D-18, 300-amp., 15 kv. and are automatic.

(c) Electrical protection—Feeder switches are protected by series trip operated from current transformers.

(d) Switchboard and metering—The 11-kv. metering equipment consists of an indicating wattmeter, voltmeter with voltmeter switch, recording voltmeter, three ammeters and three single-phase watthour cutouts.

(e) Station service—Power and lights for station use are obtained from a 5-kva. transformer connected to the 11-kv. transfer bus through primary cutouts.

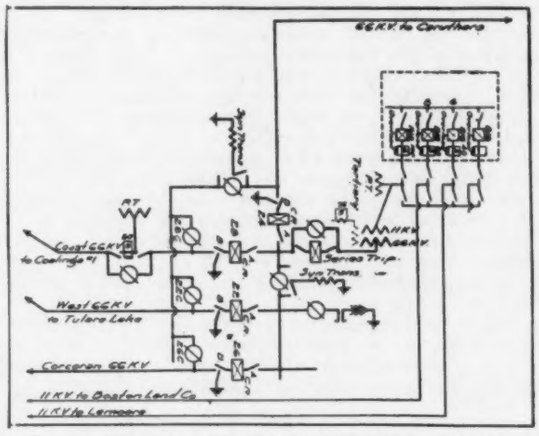

66 KV to Corcoran
Coast 66 KV to Coalinga #1
West 66 KV to Tulare Lake
Corcoran 66 KV
11 KV to Boston Land Co
11 KV to Lemoore
Series Trip
Synchronizing

Fig. 3. Schematic wiring diagram, Henrietta substation.

Buildings

(a) Substation — The substation building has a steel frame with hy-rib covering. Its floor dimensions are 31x51 ft.

(b) Cottage—The operator's cottage, garage and barn are of good frame construction.

Miscellaneous Electrical Construction

(a) Battery and charger—A 12-volt, 80-amp. battery supplies power for tripping the circuit breakers and for ringing the alarm bell. The battery is kept on continuous trickle charge.

(b) Telephones——Several phone lines run into this substation. A double bus panel, standard with this company, with double-throw switches provides switching convenience for the station phone.

(c) Ground system—Two ground wells 5 ft. square and 15 ft. deep were sunk one at each end of the transformer bus. Two-inch galvanized iron pipes, 20

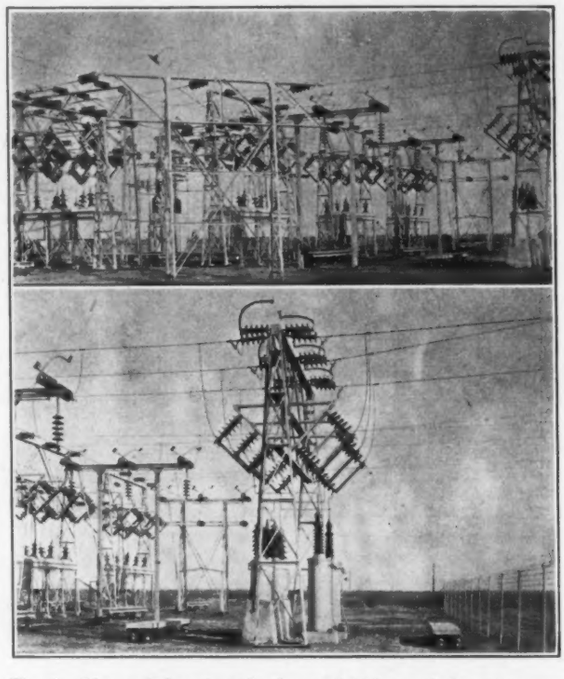


Fig. 4. Line switches, transfer bus and 70-kv. metering structure, at the extreme right (above); close-up of the 70-kv. metering structure (below).

ft. in length were driven in each corner of each well. The bottom of the wells are in moist earth. A copper mat at the bottom of each well connects the pipes. The wells are filled with charcoal and salt. Ground leads of No. 3/0 stranded copper are connected to the ground pipes and run to all transformer neutrals, steel structures, ground switches, oil-switch frames and transformer cases. This new ground system also was tied to the old one in use before the station was rebuilt. The exact condition of this old ground is not known.

(d) Alarm system—Pallet switches on all circuit breakers and an undervoltage relay are connected to an alarm bus energized by the 12-volt storage battery. A 12-volt gong is used for the alarm bell.

(e) Lighting system—The yard is illuminated by outdoor-type reflectors mounted on pipe standards and on the steel structures at accessible places.

(f) Conduit and underground system—All control and metering wires are run underground in conduit as well as station light and power wires.

Miscellaneous General Features

(a) Water supply—When the old substation was built a 90-ft. well was drilled but the water was unfit for use. Hence all water used at the substation has to be hauled in from a point about 5 miles distant.

(b) Miscellaneous—Very little grading and leveling was done as the substation site is on flat ground which was once a lake bed. A 7-ft. Elwood fence on steel posts with barbed wire on top was constructed around the switch yard and substation building. A cess poll 40 ft. deep takes care of sewage disposal.

There are two 3-gal. chemical extinguishers in the cottage while at the substation there are four 1-qt. extinguishers.

Distribution Substations of the Pacific Gas and Electric Company

By SUBCOMMITTEE ON DISTRIBUTION SUBSTATIONS*

Station J, San Francisco—11/4 kv.

Station J is a new substation at Commercial and Leidesdorff Streets, San Francisco, built to replace old station J which was inadequate and offered no chance of growth or expansion.

The new station is a steel and concrete building consisting of a basement and five operating floors. It is equipped with an automatic passenger and freight elevator, intercommunicating telephone system for speed and convenience in construction and operation, and a crane having an electrical lift and manual travel. The structure is supported on piles driven to hard pan and as the basement floor is below high tide level a water-proofing membrane being embedded in the basement floor and walls. To eliminate noise and vibration the machine foundations are isolated from the main floor, felt strips being installed between adjacent building walls with the regulators installed upon 1½-in. cork pads.

On account of the lack of space in the crowded business district the substation occupies the entire lot which is L-shaped, 55x120x85x61 ft. The 11-kv. bus structure is installed on the fourth and fifth floors. Although this scheme introduced certain complications in bringing away the 11-kv. cables, these were more than over-balanced by the short control-conduit runs to the switchboard immediately below.

Electrical Equipment

A double-bus structure of reinforced concrete; 500-amp., 15-kv., 3-pole, single-throw type H-203 oil switches; disconnects each side of the oil circuit breakers, and current and potential transformers in separate concrete compartments filled with wood and transite doors comprise the scheme of arrangement.

Incoming circuits are 11-kv., 3-conductor lead cable of 500,000 circ.-mil size, 3-phase delta, and equipped with ammeters and reverse-power relays. Machine and transformer-bank circuits are 11-kv. and equipped with watthour meters, ammeters and overload induction relays. No reactors are provided for.

Transformer bank—Four 2,500-kva., 11/4 kv. OIWC transformers with 2½ and 5 per cent taps on the high-tension side. Three transformers compose a bank, with one spare equipped with transfer switches and bus so that the spare may be cut into service under load and without service interruption.

Four-kv. bus—A double-bus structure with reinforced-concrete division walls, angle-iron and transite cells, wood and transite doors serves the low-tension. B 13, 1,500-amp., 15-kv., 3-pole, single-throw; and K132B, 400-amp., 15-kv., 3-pole, single-throw oil circuit breakers with disconnecting switches on the line side furnish flexible line control. Current and potential transformers are arranged in groups in separate compartments. Distribution feeders are 4/0, 3-phase-Y with grounded neutral.

Regulators—Automatic 200-amp. induction regulators, 10 per cent boost or buck, are installed on each feeder and mounted directly underneath the 4-kv. bus cells. Auxiliaries are mounted on panels on each regulator. Oil circuit breaker controls, automatic-reclosing relays, and instruments are mounted at each regulator bay thus eliminating long conduit runs across the station and up to the switchboard room. One white and one red indicating lamp are installed at the main switchboard to give the operator indication of the position of each feeder. With feeders out of service no lamp indication shows. With feeders in service a red-lamp indication shows. When feeders are locked out by the reclosing relay the white lamp shows. With this arrangement the operator at a glance can tell the feeders out of service; the feeders in service; the particular feeders in trouble and consequently locked out.

Fig. 1. Double-bus 11-kv. switch gallery, Station J.

A hand-reset, grounding-protective relay is installed on each bank of regulators that will lock the feeder out and give an alarm only in the event of a regulator failure. Sheet-metal oil dams of sufficient height to hold all of the oil contained in one regulator are installed to confine the burning oil in case of a tank failure. These dams are easily removable without the use of tools so that a regulator may be removed and another installed in the least possible time. No current-limiting reactors have been provided for.

Exit to the street manholes is by way of the basement through 4-in. fiber ducts embedded in concrete. The 11-kv., 4-kv. and 250-volt cables each are in separate duct lines.

Rotating machinery—Three 9,000-amp., 230-290-volt d.c., booster-type synchronous converters constitute the present installation, with space for three additional units. These machines supply the 125-250-volt d.c. Edison 3-wire system in the downtown district. The converter transformers are located in the basement directly underneath the a.c. end of each machine thus insuring the shortest possible low-voltage a.c. leads. This arrangement eliminates the trouble often encountered due to the strong field induced by the heavy alternating currents. This layout allows a very con-

* R. B. Kellogg, chairman; S. J. Lisberger, E. A. Crellin, B. D. Dexter, H. T. Sutcliffe; all of the Pacific Gas and Electric Company.

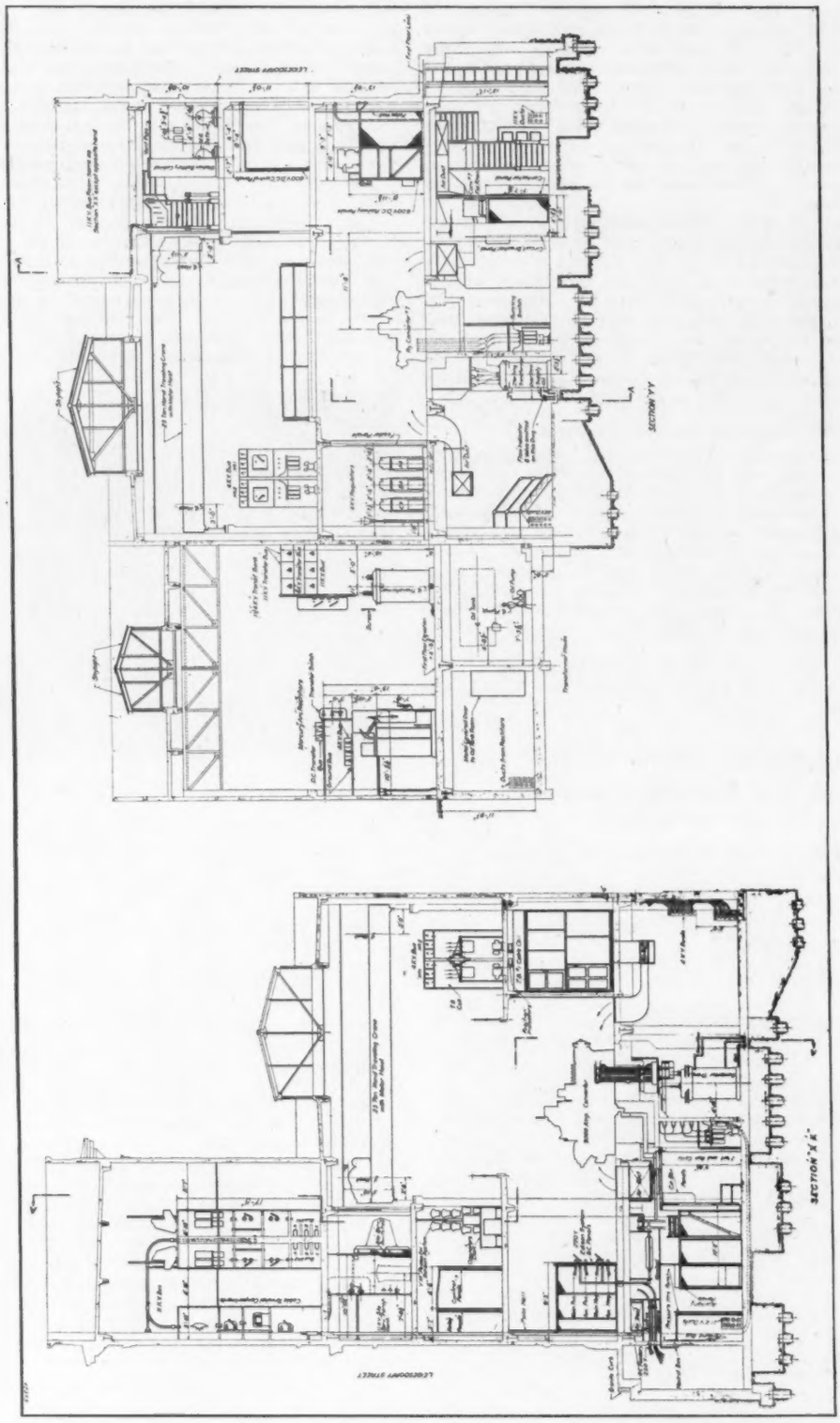


Fig. 2. Sections through the station at the two different points showing the general arrangement of equipment, Station J.

venient and economical location for the start and run oil circuit breakers which also are in the basement directly in back of the 3-phase transformer. The start and run switches are connected in the high-tension side of the transformer.

The d.c. leads are 6 leaves of ¼x6-in. bus copper, from the machine terminals to the d.c. switchboard. The a.c. low-voltage leads are 3 leaves ½x4-in. copper, from the transformer terminals to the a.c. rings. The 11-kv. leads are 4/0 varnished cambric, double flame-proof braid in the start and run cells and 4/0 3-conductor paper-insulated, lead-covered cable from the bus switches to the start and run switches.

Converters are rated 9,000-amp., 260-volt d.c. with 15 per cent buck or boost. Transformers are rated 2,820 kva., 11.5 kv. high-tension delta to 190 volts low-tension diametrical 3-phase and 6-phase. They are water cooled, type WCTH.

Both transformer and converter are capable of 100 per cent overload for a short time and are arranged

for star-delta starting. They also are arranged to restore the Edison system, in case of a complete shutdown, by first picking up the load on the star connection at a reduced voltage (full buck) then transferring one converter at a time from Y to delta connection and adjusting the buck and boost voltages to properly parallel the machine. When all converters have been transferred to the delta or running position the voltage is raised gradually to normal conditions.

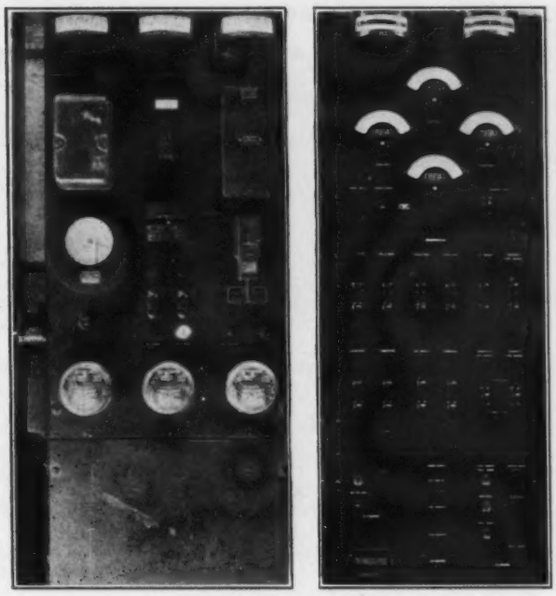


Fig. 3. Typical 4-kv. regulated circuit control panel (left). The bank of regulators is immediately behind the panel. Right—control panel for 9,000-amp., 250-volt converter, station J.

The flashing of the shunt field to insure correct polarity is arranged for either manual or automatic control.

These converters also are arranged with an auxiliary positive d.c. circuit breaker in series with a load-limiting resistor so that upon current reversal of short duration they will drop their load momentarily and return to normal without tripping off the bus. This feature is automatic.

Relay protection is as follows: a.c. induction overload; a.c. induction undervoltage; d.c. reverse power and underload; a.c. and d.c. grounding relay; overspeed device.

Control circuits and switching are so interlocked that an operator cannot risk his own life or damage the converter by making an error. The d.c. switchboard consists of one main bus and one auxiliary bus. Bus-tie breakers of 14,000 amp. normal rating and 28,000 amp. 5-min. overload rating are installed for paralleling. The d.c. feeders are not fused, but are equipped with both positive and negative ammeters.

Railway Apparatus—One 1,000-kva., 600-volt d.c. synchronous converter for railway service is installed. All operations of this machine are automatic, from the closing of the starting switch to the closing of the d.c. bus breaker. They are equipped for manual operation in emergency. The 600-volt d.c. board consists of a machine panel and five 600-volt d.c. railway feeders each equipped with high-speed circuit breaker protection. The relay protection for the converter is the same as for the 250-volt converters.

Miscellaneous

Storage Battery and Chargers—One 60-cell, 200-amp.hr. storage battery of the chloride accumulator type is installed in a redwood cabinet consisting of three shelves each holding 20 cells. The charging apparatus consists of two 7,500-watt, 100-200-volt d.c. motor generator sets driven by 3-phase, 220-volt a.c., 60-cycle induction motors supplied either from the 11-kv. or the 4-kv. house bank. The d.c. charging bus is equipped with a sectionalizing disconnecting switch so that in case a gassing charge is required the voltage may be raised to 160 volts on one motor-generator and battery while the control lights and switch operations continue at 130 volts during this time, supplied by the second motor-generator set.

Alarm System—An annunciator and alarm system notifies the operator by means of lamp and horn indication in the event of switch trip due to overload, transformer temperature, transformer water failure charging set failure or other difficulties. The

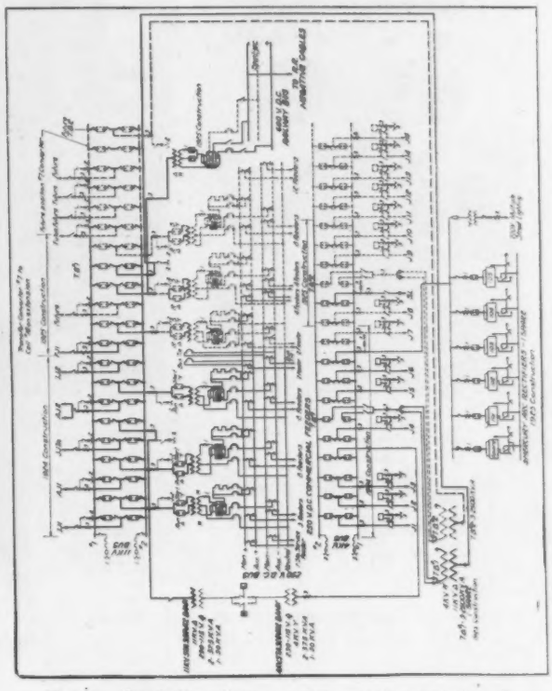


Fig. 4. Single-line diagram of connections, station J.

transformer water is circulated at 7-lb. pressure by two 1½-in. centrifugal motor-driven pumps, one a spare, and cooled by a specially designed cooling tower located on the roof of the building.

Oil Storage—A tank and pump are installed in the basement for oil storage and the piping so arranged that the oil may be pumped from the transformers and stored, filtered, or drained to barrels as required.

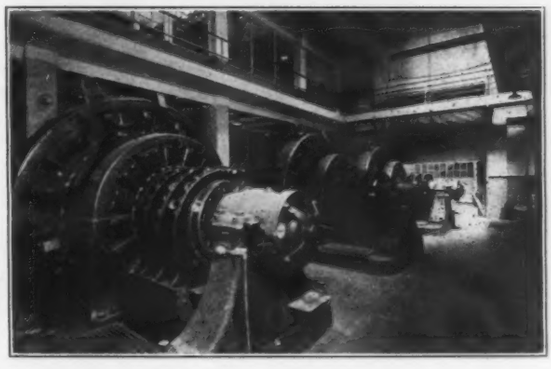


Fig. 5. 9,000-amp. booster converters; operator's room above.

Air System—An air system is installed for washing and circulating air for properly ventilating the building, with special provision for cooling the synchronous converters and induction regulators. Main switches on the blowers are located near the street door so that they may be shut down in case of fire without walking through the building to the basement. Air is drawn from the roof through an air duct to the basement. There it passes through a water-spray washer and drier and is circulated throughout the building from this location. Air ducts

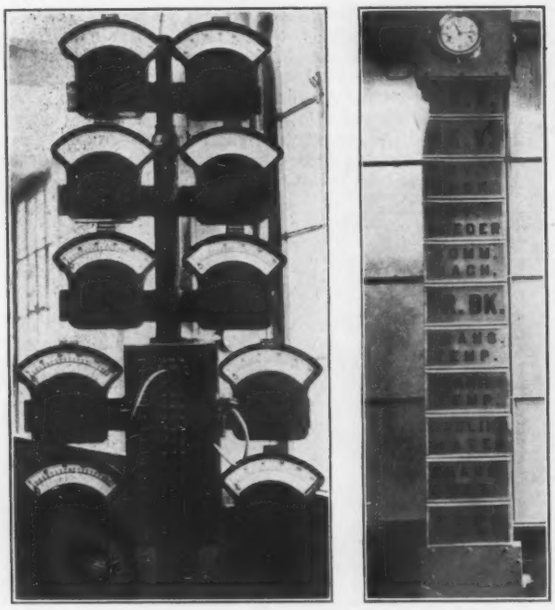


Fig. 6. .Annunciator and alarm pedestal (right) and pressure-wire voltmeter pedestal for Edison system (left), station J.

are covered with a cork paint to prevent condensation when they pass over live apparatus or parts which would be damaged by moisture which might otherwise collect and drip. Each duct opening is equipped with a register of special design for controlling the air discharge.

Emergency Lights—Emergency lighting is provided by a relay which, upon failure of the a.c. supply, switches certain circuits normally feeding from the a.c. panel boxes to the d.c. until the a.c. is restored. This method eliminates dark lamps in the station and saves duplicate circuits and wire. Station light and power is supplied from two banks of transformers fed either from the 11-kv. or the 4-kv. bus respectively. The switchboard for station-power control is of pipe construction with safety-type enclosed fused switches. Station lighting is controlled from dead-front panel boxes on each floor.

General Arrangement

The general arrangement of each floor of the station is as follows:

Basement—Synchronous converter transformers, d.c. circuit breakers and field rheostats, start and run switches, cables and duct lines to street, water circulating pumps, air washer and blowers, oil tanks and pump.

First floor—9,000-amp. converters, 1,000-kw., 600-volt converter, induction regulators, d.c. 250-volt switchboard, d.c. 600-volt switchboard, 4-kv. house bank, 7,500-kva., 11/4-kv. transformer bank, magnitite street lighting transformers.

Second floor—Operator's control room, 4-kv. bus structure.

Third floor—Storage battery and charging sets, air compressor, 11-kv. house bank, switchboard for station light and power.

Fourth floor—11-kv. bus structure and cable cells.

Fifth floor—11-kv. oil circuit breaker gallery.

The present equipment will deliver 7,500 kva. of 4-kv. load, 7,000 kva. of 250-volt d.c. commercial load, and 1,000 kva. of 600/1-volt railroad load. The ultimate development of this station will be double this capacity.

Telephones—No booth is required as the operator's control room is entirely enclosed. The telephone equipment consists of a city phone and one-party-line phone between substations on wires leased from the telephone company. The local intercommunicating phone covers each floor of the building. Magnavox anti-noise phones are used on the main machine floor.

Fire protecion—Pyrene and soda-acid extinguishers are conveniently arranged on each floor.

Drains—The basement is drained to a sump equipped with a vertical centrifugal motor-driven pump operating under automatic float control.

Street lighting equipment—Five 75-light magnitite street-lighting transformers and two 4-kv. circuits for RO regulating transformer circuits are installed at present.

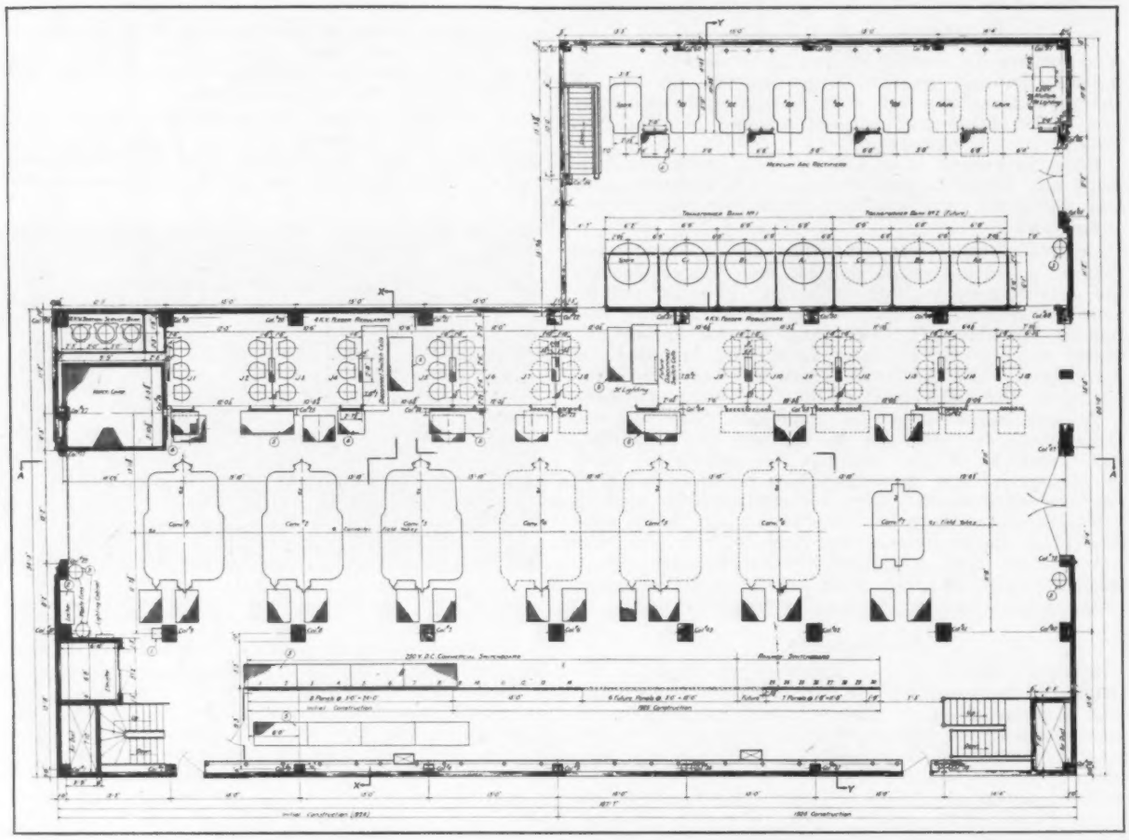


Fig. 7. Plan of first floor showing general arrangement of equipment, station J.

Station L, San Francisco—11/4-kv.

This new substation has been constructed in San Francisco at Ocean Avenue and Junipero Serra Boulevard to serve the rapidly increasing load in the residential districts surrounding this location.

The building is of steel and concrete and of two story design, without a basement. The outgoing and incoming cables are handled in subways under the main station floor. A separate building accomodates the self-cooled transformer bank and the spare unit. Transfer switches and a bus for shifting the load to the spare when necessary are provided.

Fig. 1. Exterior station L giving idea of architecture.

At present the station will deliver 4-kv., 3-phase, 4-wire service, star with grounded neutral for distribution. It is so designed that it may be extended to permit the addition of 600-volt d.c. railway apparatus when the occasion arises.

Station L requires no operators and is equipped with supervisory control from the dispatching station, located approximately four miles distant. The supervisory equipment is capable of operating 50 switches together with all lamp indication over four interconnecting wires. These wires are owned by the Pacific Gas and Electric Company, and are placed underground the entire distance.

Specifications on the interconnecting cable are as follows: 10-pair No. 19 B & S copper insulated with two wrappings of dry paper, two paper tapes over core and a 3/32-in. lead sheath; insulation resistance 500 megohms per mile; and mutual electrostatic capacity not greater than 0.066. Additional wires are for telephone, spares, and other possibilities. The dis-

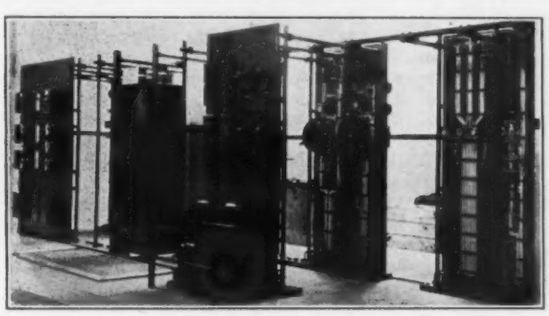


Fig. 2. Switchboard room showing charging sets, supervisory cabinet and control panels, station L.

patcher's switchboard is designed with a dummy bus and control-switch arrangement similar to an operator's switchboard for manual control. This was done to eliminate confusion. At station L the control for all switches is arranged so that by means of a transfer switch the station may be operated manually, with an attendant, or from the dispatcher's station by supervisory control. Wires for the manual and the supervisory control are in separate conduits and have no connection except at the switches which they control. Also, separate batteries and charging apparatus are installed for the supervisory system.

This slight increase in expense of installation is but a small percentage and was made so that in event of trouble with the supervisory system the station could be operated manually by sending an attendant

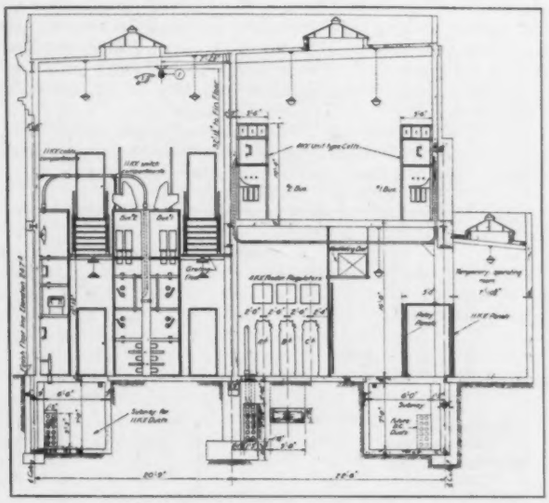


Fig. 3. Section through station L showing arrangement.

there temporarily. This being the case the two systems were installed entirely separate so that neither would be affected by the other in case of line or station supervisory failure. The 11-kv. and 4-kv. buses and the supervisory circuits each have a separate fused control switch and, the station being unattended, it was thought at one time to install a relay or other devices which would give indication in case a control fuse failed. However, this introduced complications and was not done, but left to future experience to ascertain the possibility of demand of such an arrangement.

At present station L is supplied by two 500,000 circ.-mil, 3-conductor, concentric lead cables operated 11 kv., 60 cycles, 3-phase delta and two banks of 3,000-kva. transformers, 11/4-kv., each bank consisting of three 1,000 kva., self-cooled units and one spare. Space is provided for two more banks of 10,000 kva. each in case future load warrants this capacity.

Station Details

11-kv. Apparatus — Two 11-kv., 3-phase, 60-cycle buses, fitted with disconnecting switches between circuit breaker and bus and breaker and line give flexible control of power. Current and potential transformers serve as needed. Type H-203, 3-pole, single-throw, electrically operated (125 volts d.c.), 500-amp. oil circuit breakers are installed. Each group is in a separate compartment built of reinforced concrete and with wood-and-transite doors. At present there are six cells installed but the building is designed to accommodate 14 cells. The 11-kv. bus structure has an iron grating at the circuit-breaker level to permit

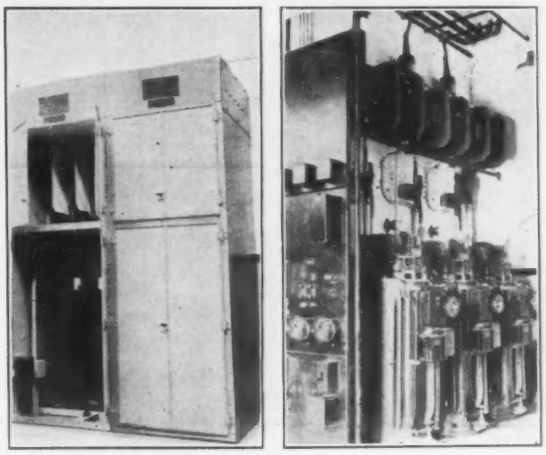


Fig. 4. Right, typical circuit regulator equipment showing control panel in front carrying instruments and manual-supervisory transfer switch. Left, typical all-steel 4-kv. feeder and bus compartments, station L.

working on the switches. Operation indicators of mechanical design are installed to give indication at the disconnecting-switch floor when breakers are opened or closed. A trolley beam is installed over the 11-kv. structure to permit easy handling of the breaker mechanisms for installation and repair.

The 11-kv. incoming cables are equipped with ammeters and induction-type reverse-power relay protection. No reactors have been provided for.

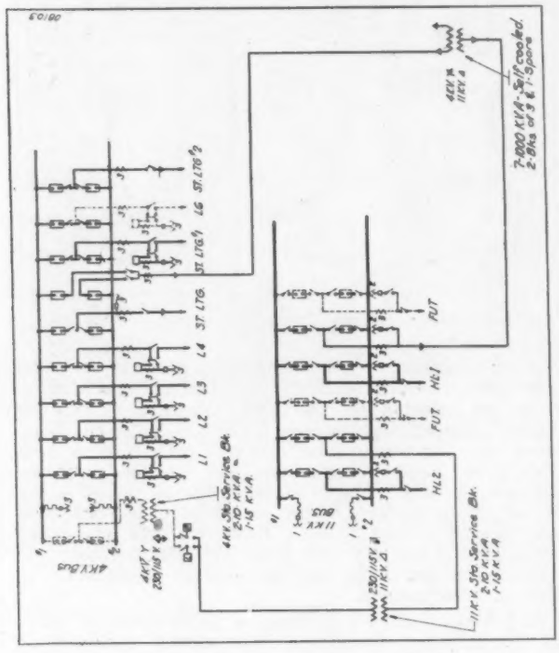


Fig. 5. Single-line wiring diagram, station L.

Transformer banks—Installed in separate buildings are seven 1,000 kva. OISC units, 11/4-kv., 6 main and one spare. A transfer bus and switches in concrete-and-transite cells permit cutting in spare units under load. Watthour meters, indicating wattmeters and overload induction relays are on the 11-kv. side; the 4-kv. side is non-automatic, ammeters only. Interconnecting cables are paper-insulated, lead-covered and are installed in 3½-in. fiber duct. Temperature alarm indication at the switchboard when the station is operated manually. No alarm indication is provided for when operated by supervisory control.

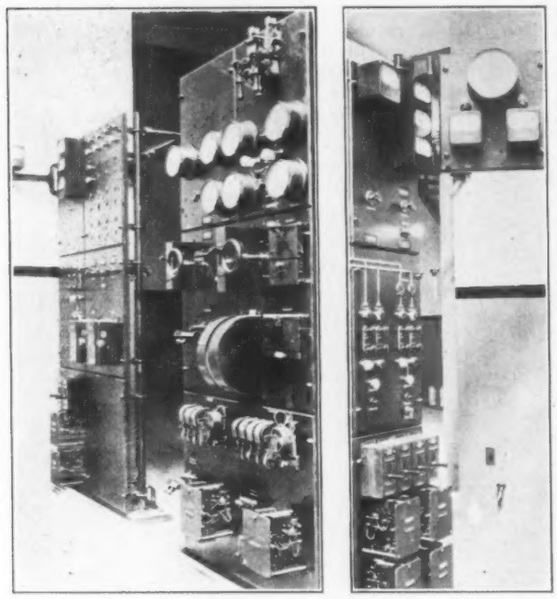


Fig. 6. Right, 11-kv. circuit control panel showing supervisory transfer switch and trip-free relays on lower panel. Left, 4-kv. indicating and transformer control panels; automatic trickle-charge control panels in foreground, station L.

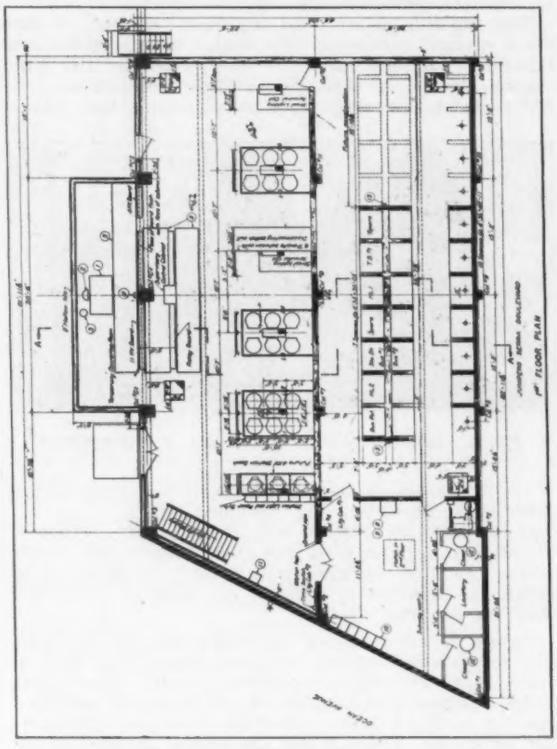


Fig. 7. Plan of first floor, station L.

4-kv. apparatus—At present there are seven cells installed, but the building is designed to accommodate 14 cells. Two 4-kv., 3-phase-Y buses are provided. Disconnecting switches are installed between the lines and breakers only. Circuit breakers are in all-steel-and-angle-iron cells fitted with steel doors. Separate compartments are arranged for breakers, disconnecting switches, and bus. Steel unit-cells are on the second floor; current transformers, regulators and auxiliaries are directly below on the main floor. Oil circuit breakers are 400-amp., 3-pole, single-throw, K-132 B, and solenoid-operated at 125 volts d.c. No provision has been made for reactors. Three single-phase, 200-amp. induction regulators are installed for each feeder. All regulators are mounted on cork pads to reduce vibration and consequent noise. Auxiliaries are mounted on panels on the regulators. Each regulator bay is equipped with an easily removable oil dam to confine the flow of oil in case of explosion. The control panel for each feeder is mounted at the regulator bay. This panel has three ammeters, control switches and lamps, curve-drawing voltmeter, relays, and transfer switch to provide either manual or supervisory control. A grounding relay is connected in series with the regulator ground wire so that in case of regulator failure the relay will clear it from the bus and sound an alarm.

Street light circuits are operated single phase and controlled by standard 4-kv. feeder equipment. Each single-phase circuit is used to supply RO street lighting transformers in the surrounding district. In case any oil circuit breaker trips, the circuit in trouble is identified by means of the target indication in the induction overload relay. By means of a disconnecting switch the faulty phase may be opened and the breaker closed again.

Station service is supplied by an 11-kv. transformer bank with standard 11-kv. equipment plus a watthour meter. These station service transformers have special high-tension taps to reduce the low-tension voltage to within the rating of station auxiliary apparatus.

Grounds—All grounding wires including the 4-kv. transformer-bank and feeder neutral are brought to two copper ground buses located one at each end of the station. These copper ground buses are connected to groups of four copper ground plates buried to a depth of permanently moist earth and embedded in charcoal ground to the size of a a chestnut. Water is piped to each set of plates for watering the ground periodically. The flow is regulated by valves mounted in the station near the ground buses.

Miscellaneous

Station control battery—The main control battery is composed of 60 E11 chloride cells, 120-140 volts d.c., mounted in a redwood cabinet fitted with sliding glass doors. This battery receives a trickle charge from a 1,500-watt-motor-generator set automatically controlled for stop and start in case of a.c. failure. Automatic relays keep the charging set off the line unless the d.c. charging voltage is 129, or 2.15 volts per cell. In case the charger fails on indication an alarm is given to the dispatcher in the controlling station, if operated by supervisory control. If the station is being operated manually at the time of failure a signal and alarm is sounded in the station on the annunciator.

The supervisory system has its own 120-volt battery composed of 60 7-amp.-hr. chloride cells mounted in a separate redwood cabinet. This battery receives a continuous trickle charge from a 250-watt motor-generator set automatically controlled similar to the main control-battery equipment.

Telephones—The telephone equipment consists of one city line and one local substation line. No booth is required as there are no rotating machines and no noisy apparatus in the room.

Alarm system—If the station is being operated manually the transfer switch for manual control automatically cuts in the station alarm and annunciator system which will continue to function until the transfer switch is thrown to the supervisory position. The alarm system consists of annuciator units which light a white light behind a ground-glass panel bearing the names of the piece of apparatus in trouble. At the same time a signal horn sounds and a white bull's-eye lights up on the panel upon which the particular feeder control is mounted. The horn and white light continue until the operator releases them by pushing a release button on that panel. One feature of the alarm system is that no indication or alarm will be given unless the breaker has tripped due to the action of the relays and not by manual operation.

Lighting system—One special feature of the lighting system is that no emergency lights are installed. This eliminates double fixtures in places where space is limited. An emergency fixture always is dark except in the event of trouble, and is unsightly and increases the cost of conduit, wire and fixtures. The lighting system used comprises several circuits from the main panel box which, by means of a relay, are transferred automatically from a.c. to d.c. upon failure of the a.c. house service.

Air system—The building is laid out for air cleaning and forced ventilation when such becomes necessary.

Fire protection—No fire protection is installed other than fire extinguishers located on each floor.

Landscaping—Trees were purposely left upon the site where they did not interfere and shrubs and flowers planted at suitable places. An automatic sprinkler system with spray nozzles and valves is installed to water the lawn. Ornamental lamp posts are installed to illuminate the grounds and drives.

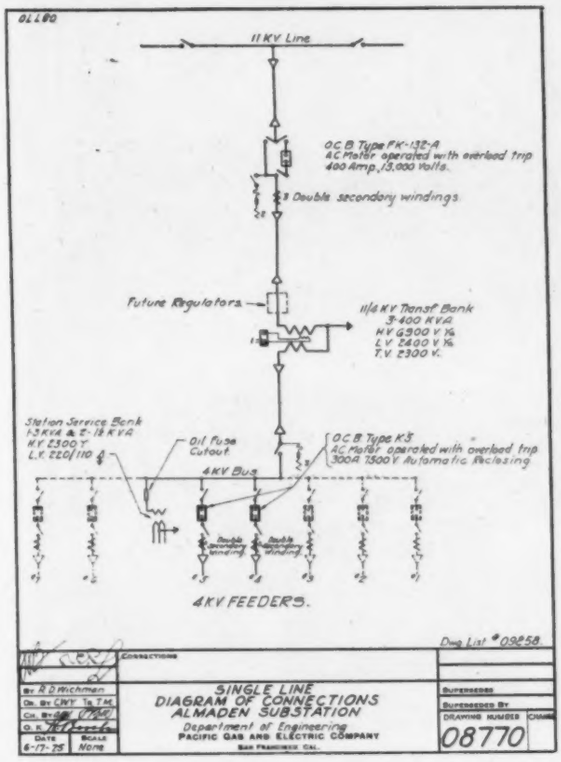


Fig. 1. Single-line wiring diagram, Almaden substation.

Almaden Substation—11/4-kv. Rural

Almaden substation is a modern rural distribution station located in the vicinity of Almaden, approximately 10 miles from San Jose, Calif. It supplies power at 4 kv., 3-phase for irrigation and farm equipment in the surrounding district.

The interesting feature of the Almaden substation lies in the fact that with the exception of the transformers, and regulators when installed, all the switches, relays and instruments are located in steel unit-cells

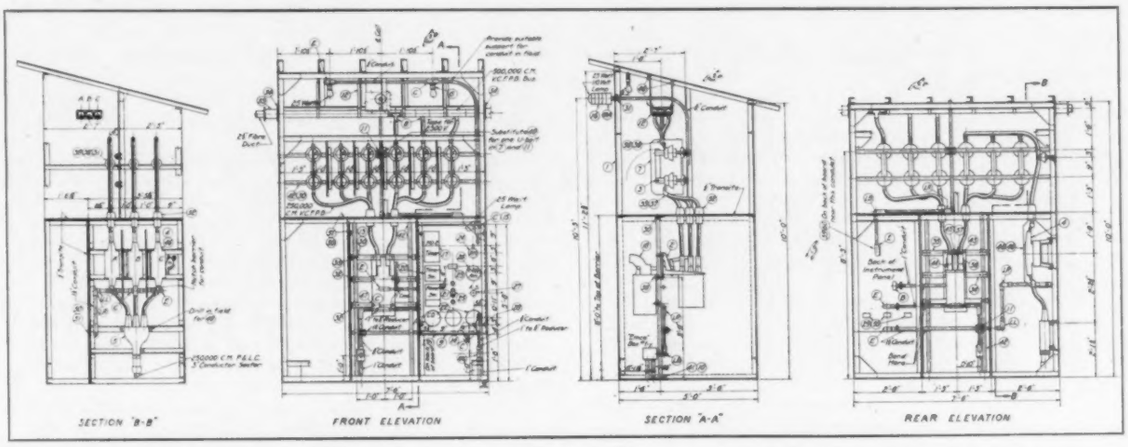


Fig. 2. Details of 4-kv. switching and metering equipment housed in steel unit-cells, Almaden substation.

and that the 11-kv. and 4-kv. cables to the transformers are lead covered, the lead wiped directly to brass nipples in a cable terminal box which is a part of the transformer itself. This arrangement permits the use of indoor equipment without requiring a building to house it.

The steel unit-cells are 6x9 ft. in plan and 11 ft. high, with steel doors front and back to permit of access to all parts of the equipment. They are built on 2½x2½x¼-in. angle frame covered with No. 18 gage sheet steel. Each cell is equipped with suitable light and power outlets. Insulated wooden platforms are installed outside of and opposite each set of doors.

Station Details

Incoming lines—Two 11-kv., 3-phase, 60-cycle-Y, grounded overhead lines are brought in to a dead-end pole and equipped with air-break disconnecting switches, and thence through lead cable to the transformer-bank cell.

Transformer bank cell, 11 kv.—Each steel-unit cell contains one K-132-A, 400-amp., 15-kv., 3-pole, single-throw oil circuit breaker equipped with MK-3 a.c. operator; three overload induction-type relays with tripping reactors; one polyphase watthour meter; one curve-drawing ammeter and ammeter switch; and current and potential transformers. Disconnecting switches are installed each side of the breakers; by-pass disconnecting switches provide emergency control.

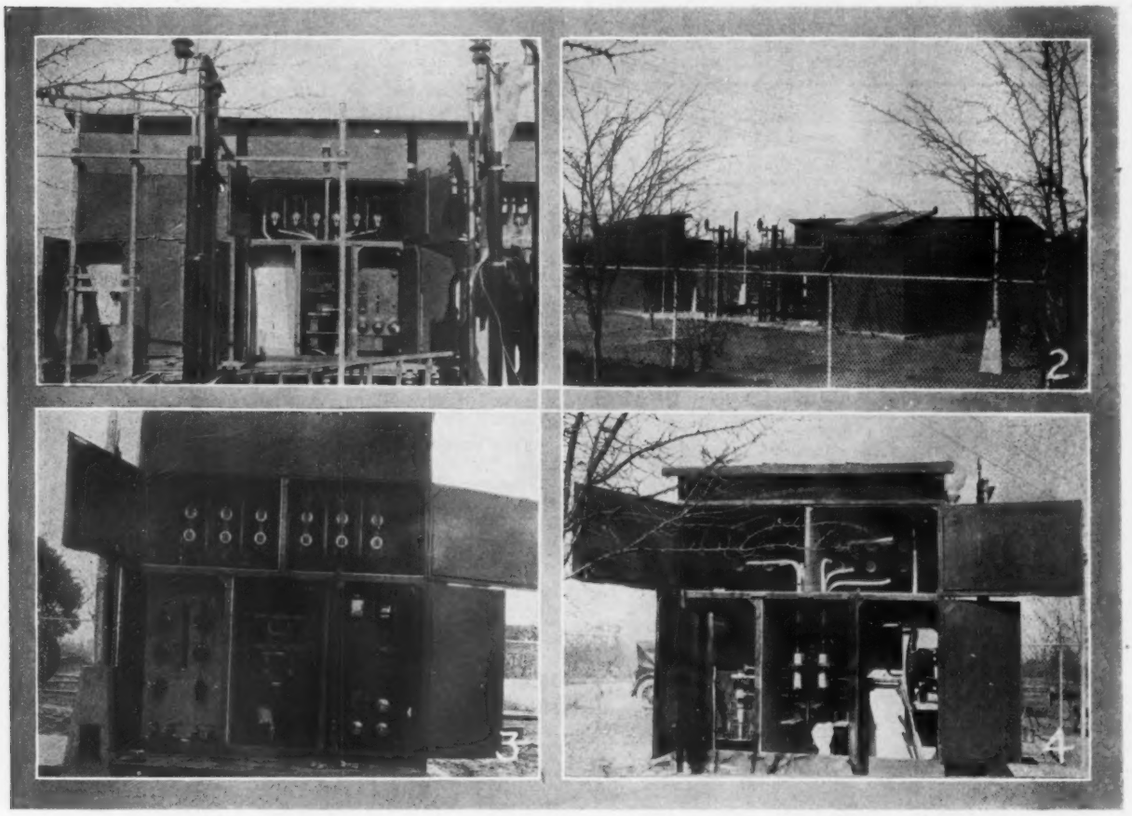
Main transformers—Three 1,000-kva., OISC, 11/4-kv., single-phase transformers equipped with terminal boxes and brass nipples for lead-cable connection are installed. Both high-tension and low-tension leads thus are weather-proofed.

Transformer bank and feeder cell, 4.1 kv.—Each steel-unit cell contains disconnecting switches on transformer leads to the single bus; one 4-kv., 3-phase-Y-distribution feeder equipped with one K-5, 300-amp., 7.5-kv., 3-pole, single-throw oil circuit breaker with an MK-3 a.c. operator and tripping reactors, disconnecting switches each side of the breaker; three overload induction-type relays; current and potential transformers; one recording voltmeter and voltmeter switch; one MD-2 automatic-reclosing timing relay; and one type H-2 demand meter.

Station light and power cell—One steel-unit cell contains three 1½-kva., single-phase, 2,300/230 115-volt, OISC transformers equipped with S&C fuses.

Station utility cell—One steel-unit cell contains telephone equipment; lighting cabinet; spare parts; service equipment.

Station grounds—All switch frames and structural steel and neutrals are connected solidly to two ground plates buried in permanently moist earth. The ground plates are cast iron 18x30 in. in dimension. No charcoal was used.



Almaden substation: (1) 4-kv. all-steel compartments for outdoor service; (2) general view; (3) steel compartment for 11-kv. control panel and disconnecting switches; (4) steel compartment for 11-kv. oil circuit breakers and current transformers.

All station equipment is mounted on a concrete pad 6 in. thick and reinforced with ⅜-in. steel rods in both dimensions.

Only a portion of the lot is occupied, the station requiring a space 60x80 ft. This space is enclosed by a 6-ft. non-climbable Cyclone fence with a 12-ft. gate to permit entrance of trucks.

Outdoor regulators may be installed when required and the station is designed for additional feeders when the load demands such extension.

The 4-kv. feeders are automatic reclosing and no operator is required. Periodic inspection insures satisfactory operation and in case of a feeder lockout the customers are depended upon to notify the operating department.

Outside lighting comprises six single-light iron posts each equipped with a 200-watt lamp.

Gonzales Substation, Coast Valleys Gas & Electric Company; 55/4 kv.

By T. W. SNELL

This substation, which has an electrical design similar to that proposed for future rural substations, was built to replace an overloaded and unsightly old substation. Additional property was purchased so that the new station was built without interference to service. As the station is located on a main state highway an effort was made to obtain a pleasing appearance. The station is unattended, but sufficient property was purchased to add an operator's cottage in the future and to provide storage space.

High Tension

The station is supplied by tapping a 55-kv. loop transmission line. K.P.F. pole-top disconnecting switches are mounted on each side of the station to give selectivity when necessary or desirable. The rack is a delta-star galvanized structural steel design carrying a 73-kv., 3-pole disconnecting switch, transformer fuses, and disconnecting switches for primary and secondary side of each transformer bank.

Transformers as installed include three 400-kva., 55-kv. delta to 4-kv. star, self cooled; one 750-kva. spare.

Fig. 1. Partial front view Gonzales substation. Lot is to be graded and landscaped to improve appearances.

As the summer peak is considerably greater than the winter load, both banks are operated in parallel during the irrigation season and the larger bank cut out during the winter.

Protection—S&C. 73-kv., 100-amp. fuses are used to protect the 55-kv. line against transformer failure or bus trouble. No instruments are installed on the 55-kv. side.

Low Tension

The 4-kv. equipment all is indoors, mounted on 1¼-in. pipe framework. The 4-kv. leads from transformers to bus are of open wiring, entering the building in the rear through wall bushings.

Regulators—Three 200-amp. single-phase regulators are used on one circuit supplying a small town, a factory and various pumping plants within a ¾-mile radius. Three 300-amp., single-phase regulators are used for regulating the longer feeders.

Circuit breakers—The three 4-kv. feeders are equipped with Condit 400-amp. 15-kv. oil switches equipped with Condit individual solenoid automatic reclosing mechanism. Relays are set for three reclosures 8 sec. apart before lockout. Outages on the town circuit are reported by the factory which has 24-hr. attendance; outages on the farmer lines are reported by any customer affected.

Miscellaneous

Electrical Protection—The 4-kv. breakers are equipped with General Electric induction overload relays. The station transformers and future arc tub will be protected with S&C fuses.

Switchboard—Three panels of ebony asbestos 24x 90 in. are used for mounting instruments, relays and controls.

Lines—All feeders are carried underground out of the building to nearby pole lines. Cables are lead-covered, in rigid iron conduit.

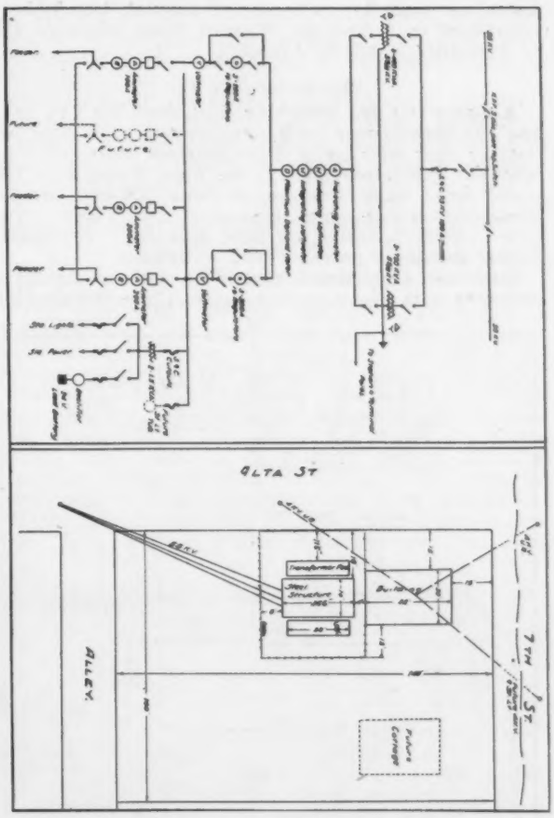


Fig. 2. Below—plot plan of substation grounds. Above—single-line wiring diagram; Gonzales substation.

Buildings—The substation building is of steel frame, with hollow-tile walls and concrete floor and roof. The outside of the building is stucco. Outside dimensions are 40x32 ft. in plan and 20 ft. high. The outdoor apparatus is surrounded by a Cyclone steel fence.

Miscellaneous electrical—A 24-volt lead battery, charged by a vacuum tube rectifier, is used for d.c. supply. The ground system is a network of 4/0 bare copper cable connected to three driven pipes.

Compton Substation, Southern California Edison Company; 15/4 kv.

By H. L. SAMPSON

The Southern California Edison Company serves many small towns and parts of larger communities where the total load is between 500 and 3,000 kva., and where this load can be kept very evenly divided between three phases. Therefore a standard type substation has been developed for this work; of this standard Compton sub is a good example. It should be noted that provision is made throughout for enlargement from the present size to an ultimate of

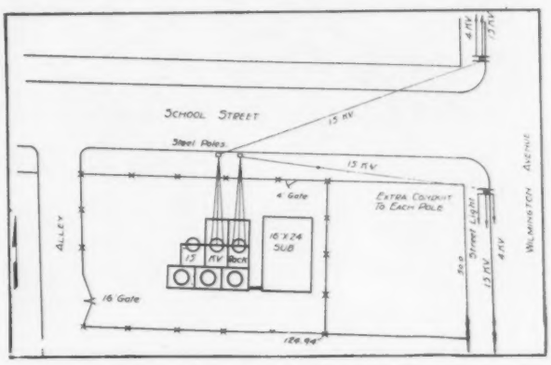


Fig. 1. Plot plan, Compton substation.

3,000-kva. capacity, to be served through two 3-phase regulators to 8 circuits. Two of these probably will be controlled street-light feeders.

Equipment—15 kv.

A single bus and switching equipment for two lines and one transformer bank is supported on a 3-section outdoor rack built up of 3 lattice-steel poles and 2-in. standard galvanized pipe. (See Figs. 1 and 3.) The transformer bank consists of three 500-kva. single-phase self-cooled units connected delta star. The 15-kv. circuit breakers are hand operated. The transformer switch is provided with a by-pass.

Electrical protection — Graded - resistance lightning arresters with disconnecting switches are installed on

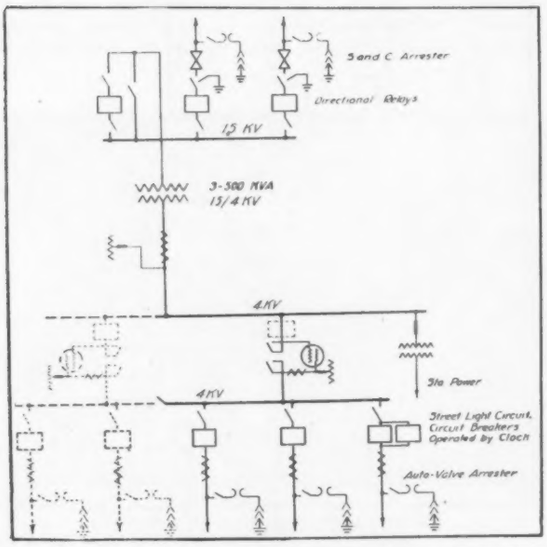


Fig. 2. Single-line wiring diagram, Compton substation.

each line. The lines are provided with directional relays operated from bushing-type current transformers in the circuit breakers. Potential is taken from the 4-kv. bus. The transformers are protected by induction overload relays also operated by bushing-type current transformers.

Switchboard—One panel, located between the two regulator panel positions carries the three sets of relays with their control switches and in addition the pull-button switches for electrically tripping the line and transformer switches.

Equipment—4 kv.

The 4-kv. equipment is all indoors and is carried on 1¼-in. standard iron pipe framework. See Fig. 4.

Regulators—Provision is made for two 4-kv. 200-amp. 3-phase induction regulators; with only one installed initially. The automatic equipment is mounted on a panel beside the 15-kv. panel. This panel also will carry the handle of a 4-kv. breaker to be installed ahead of the regulator when a second regulator becomes necessary. See Fig. 2.

Circuit breakers—The 4-kv. feeders are equipped with 300-amp. oil circuit breakers with automatic, motor-driven reclosing mechanisms. The street light circuit, also equipped with reclosing mechanism, is provided with one double-pole and one single-pole oil switch. These are so arranged that a time clock closes all three legs at one time but opens the two elements at different times; the reclosing feature is effective on all or part according to service condition. This is to provide double-schedule service. All reclosure relays are set for successive periods of 2, 15 and 30 sec.

Electrical protection—All 4-kv. feeders are protected by overload plunger-type relays operated from current transformers. Lightning and high-voltage protection is provided by distribution-type arresters located on poles just outside the station.

Switchboard—The panel which carries the total-load meters is located on the center line of the building. This provides for four positions on each side if, and as required. The space above the totaling meter panel will be used for a disconnect switch panel to tie the two halves of the bus together. Panels are of black, marine-finish marble, 28x48x2 in. with 24-in. sub-panels.

Graphic meters are used on the total load to provide a record of operation, as these stations are unattended.

Miscellaneous

Light and power for the regulator motors and reclosing mechanism is supplied from two 2-kw. transformers connected to the unregulated bus by high-rupturing-capacity fuses.

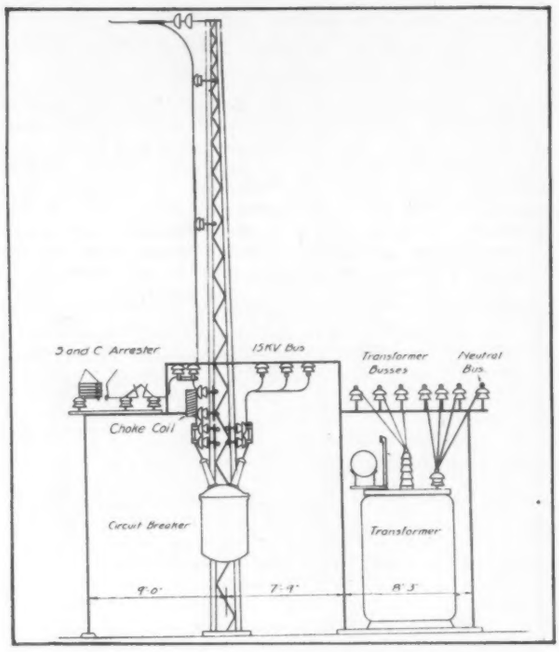


Fig. 3. 15-kv. rack section, Compton substation.

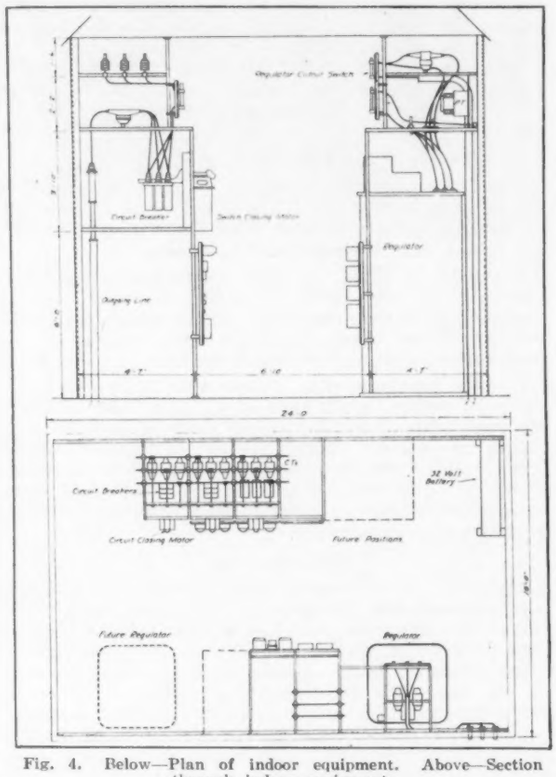


Fig. 4. Below—Plan of indoor equipment. Above—Section through indoor equipment.

All 4-kv. feeders are brought out underground to pole lines in the street through 3-conductor, paper-insulated, lead-covered cable.

The building consists of a steel frame covered with flat sheet steel. It is 16x24x14 ft. in dimension and has a concrete floor. By careful arrangement of windows and by painting the body pearl gray, the trim a darker gray and the roof a mission tile-red, a cheap fire-proof building has been made which is not objectionable in most locations.

A 32-volt lead storage battery is provided for relay operation and is charged from a vacuum-tube rectifier.

The grounding system consists of a network of bare 4/0 cable which surrounds the rack and building and is connected to all post members of the rack, all steel poles, the building, wire fence, and the transformer neutral. Copper-weld ground rods are driven and connected at various points about the network. A separate system of ground rods is provided for the lightning arresters.

All wiring is in iron conduit laid in concrete where underground and all underground wires are lead-covered.

No alarm system has been provided although serious consideration has been given to the idea of providing some arrangement for using the telephone line to transmit a signal to some nearby attended station in case of trouble. These stations also offer a fine opportunity to use some kind of supervisory system of control.

A 6-ft. heavy galvanized wire-mesh fence surrounds that part of the property used for station purposes.

Special switches and terminal strips are provided in the relay and control circuits for testing facilities.

Anita Substation, Southern California Edison Company; 60/15/4 kv.

By H. L. SAMPSON

This station is typical of the company's design of a transmission and distribution substation. Power is received at 60 kv. and distributed at 15 and 4 kv. Equipment for the two higher voltages and all transformers are located outdoors. The 4-kv. bus, regulator and circuit breakers are indoors as are the control board, meters and relays for all of the equipment. The station is in a rural district 15 miles northeast of Los Angeles. It serves a rural load, an interurban railway substation and three distribution substations. It was built in 1925. Fig. 1 shows general views, Fig. 2 wiring diagrams, and Fig. 3 a

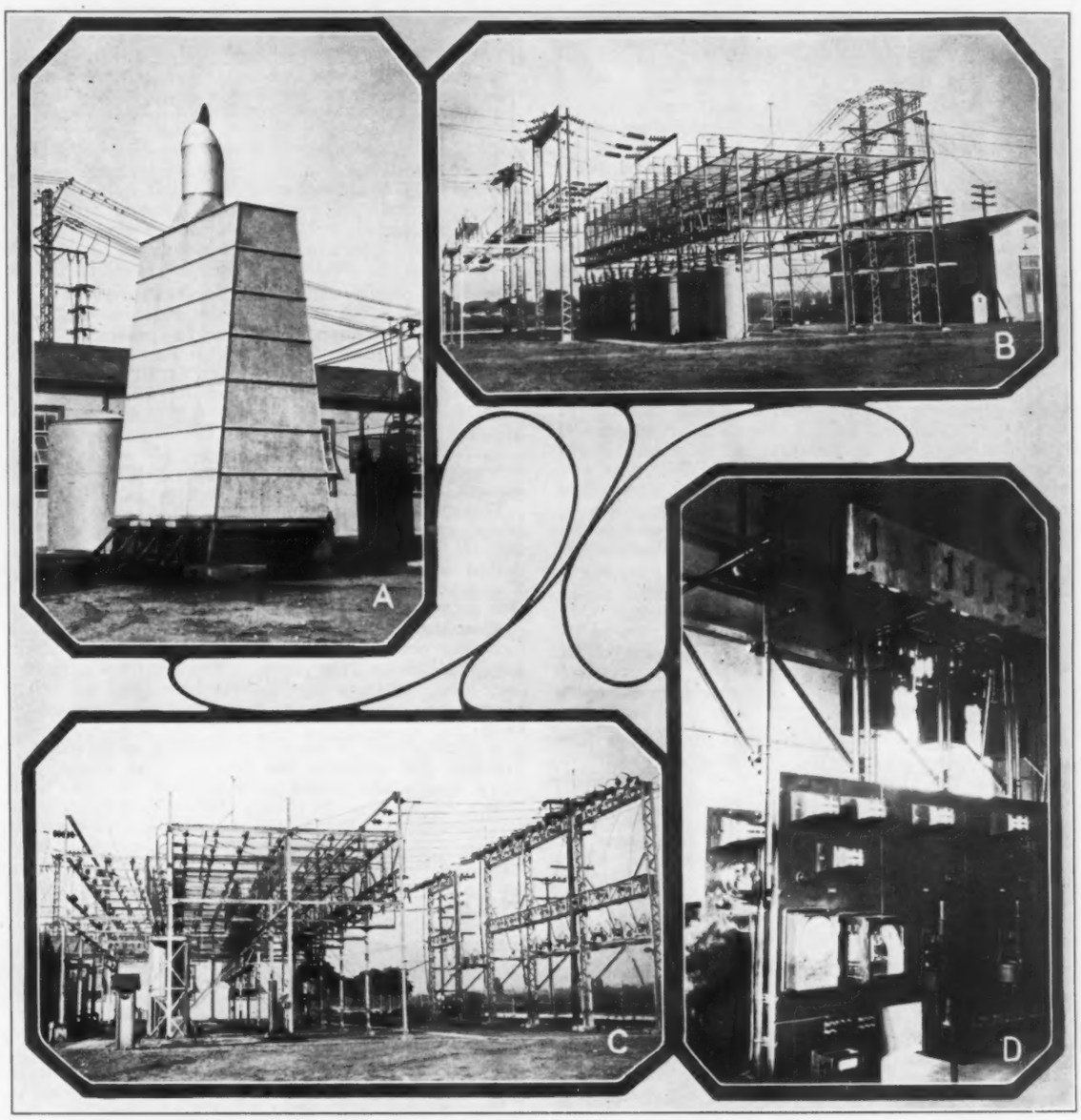


Fig. 1. (A) Cooling tower for transformer oil, and oil storage tank. (B) Substation building and 60-kv. switch rack. (C) 15-kv. switch rack and transformer bus. (D) Indoor 4-kv. switching equipment, Anita substation.

plot plan of the grounds and a section through the station building.

The division between outdoor and indoor equipment as cited above is on an economical basis, assures a minimum hazard to service in case of trouble and allows maximum spacing of equipment for maintenance purposes. The location did not cramp the design for lack of space, or require the architectural and highly protective features necessary in city substations. The initial installation provides facilities for a 50 per cent increase in the number of lines and over 100 per cent increase in capacity.

Equipment—60 kv.

Rack—There are four 20-ft. sections of structural frame work; two lines, one transformer and one bus-tie. The structure is arranged for a main and a transfer bus with the circuit breakers on the outside of the equipment. The design allows for the addition of a circuit breaker in each position should future duty on the station indicate that it is desirable to have a full double bus with duplicate circuit breakers for each circuit. See Figs. 1B and 4.

The steel frame work is of very light construction, but entirely adequate for the mild climatic conditions of southern California. Insulators are of the common

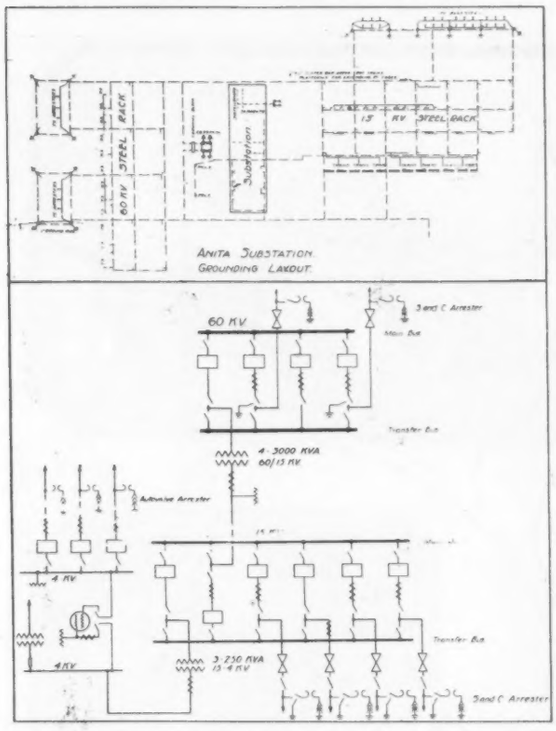


Fig. 2. Below—single-line wiring diagram. Above—grounding layout; Anita substation.

10-in. disc-type porcelain built into pillar units both for bus supports and for disconnecting switches.

To clean the insulators from dust deposits water sprinklers of a common garden rotating type have been placed above the bus work on both the 60-kv. and 15-kv. racks. It has been found that these can be safely operated with the bus energized. There has been some trouble with the type of sprinkler head used, but the method has proved excellent and is in regular use. No labor has been necessaray to date for other methods of cleaning the insulators.

Oil Circuit Breakers—These are of a type having 6 series breaks, a normal rating of 400 amp., 70 kv. and an interrupting value of approximately 400,000 kva. They are electrically controlled, but operated by compressed air. There are two bushing-type current transformers per pole with all the ratio taps brought to a common terminal board in the mechanism housing. Control power is from a storage battery in the building and the operating air from an air compressor in the building and air receivers near the circuit breakers.

Transformers—Three 3,000-kva. single-phase transformers are connected delta-star for a 66/16.5 ratio; one spare transformer is arranged so that it can be put into service by changing connections, but without moving the units. The transformers are cooled by circulating the oil through radiators separate from the transformers. These are in a chimney-shaped struc-

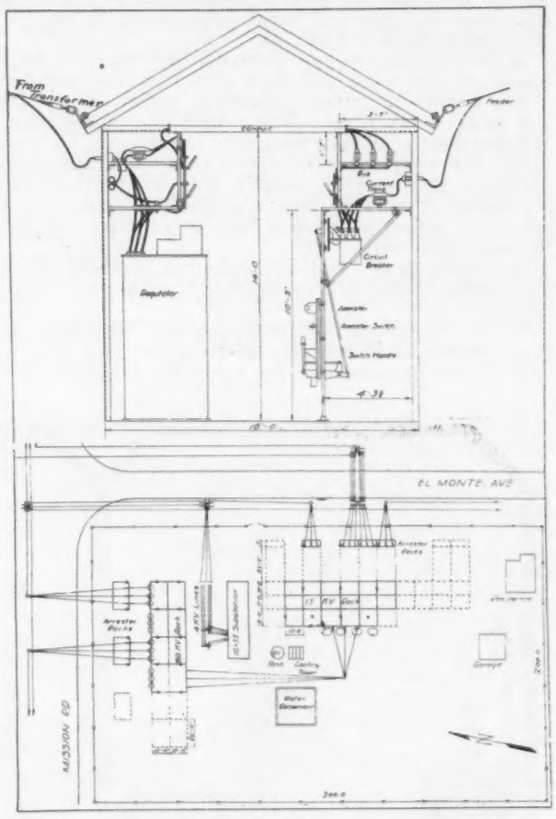


Fig. 3. Below—plot plan. Above—section through station building, Anita substation.

ture of sheet iron that produces a natural draft for cooling. See Fig. 1A.

The neutral is grounded through a current meter transformer to a ground net-work of copper cables that is carried entirely around the rack and connected to the steel and to the circuit-breaker tanks. The ground system will be described in detail later in this paper.

Electrical Protection and Control—Graded-resistance lightning arresters are connected through disconnecting switches to the lines. Transformers are protected by induction-type inverse-time overload relays. Lines and bus-tie have induction-type power-directional relays.

A vertical switch board of 32x90-in. slate panels is provided for controls and relays. The control and relay boards are placed back to back with 4 ft. between. A pit beneath the switchboards provides space for terminating the cables from the rack and for transferring connections between panels. Special terminal blocks have been arranged at the base of the panels and at right angles to them to allow as much room as possible for connections. The current-transformer leads for relays are connected to short-circuiting and disconnecting switches for use in testing. A single-pole knife switch is placed in the relay trip lead to each circuit breaker so that the breaker may be made non-automatic when desired.

Equipment—11 and 15 kv.

Rack—This is similar in construction and arrangement to the 60-kv. rack. The sections are each 13 ft. 6 in. wide, allowing room to change the circuit breakers to a type with higher rupturing capacity when the transformer capacity is increased. Pole-top disconnecting switches have been placed in the lines in

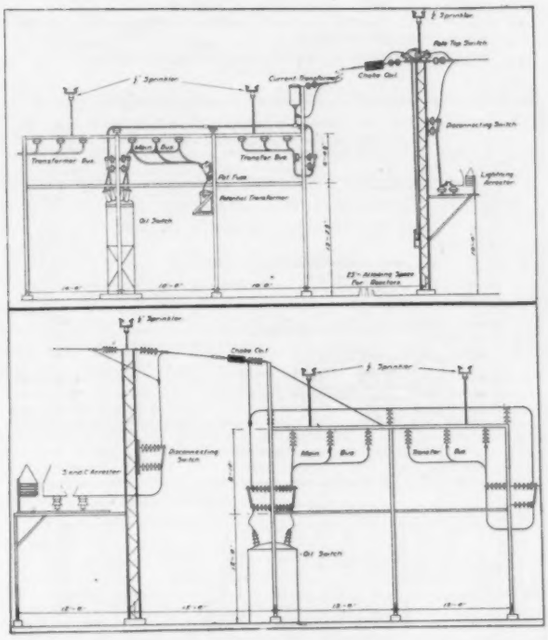


Fig. 4. Section through 60-kv. rack (below) and through 15-kv. rack showing location of sprinklers and other arrangements, Anita substation.

such a position that the lines may be cut loose from the station and either grounded or left energized from another station. Space has been provided for the future installation of current-limiting reactors to handle future capacity. See Figs. 1C and 4 for the equipment. Arrangements for washing insulators are similar to those on the 60-kv. rack.

Oil Circuit Breakers—These are single-tank multiple-break switches rated at 300 amp., 15 kv., with an interrupting capacity of approximately 100,000 kva. They are air operated, electrically controlled and have one bushing-type current transformer per pole. The control and operation is similar to the 60-kv. breakers described above.

Transformers—Three 250-kva., self-cooled, single-phase transformers are connected delta-star for service to the 4-kv. indoor regulator and bus. The construction provides for changing these to three 1,000-kva. transformers when the load increases. The 4-kv. neutral is connected not only to the general ground system of the station but is extended to the fourth overhead wire of the 4-kv. distribution lines.

Electrical Protection and Control—Graded-resistance lightning arresters are provided for each line. Induction-type inverse-time relays are used for overload protection of each circuit.

Meters, relays and controls are on the same panels with the 60-kv. equipment and are arranged in a similar manner. The control board has the usual installation of mimic bus and indicating lamps.

All 4 kv. equipment is indoors, mounted on 1¼-in. pipe framework. See Fig. 1D.

Oil Circuit Breakers—Hand-operated, 300-amp., 7.5 kv. breakers are used, having a rupturing capacity of 25,000 kva. They are provided with secondary overload plunger trip coils in the operating handles. The overhead mounting and control rods are plainly visible in Fig. 1D.

Regulator—Voltage is held constant by a 3-phase, 100-amp., induction-type regulator in the transformer feed to the bus. Space has been left so that this can be replaced by two 200-amp. regulators. By-pass switches are arranged to cut the regulator out of service for maintenance purposes.

Lightning Arresters — Distribution-type lightning arresters are mounted on the first pole away from the station.

Buildings—The substation is a 16x56-ft. sheet-metal building made from two 16x24-ft. buildings such as used at smaller stations. A cottage is provided for the regular operator and his family. A combination garage and sleeping quarters are provided for the relief operator. Regular fire protection for this class of station is as follows:

One 10-gal. Carbon tetrachloride engine on wheels.
One 1-gal. Carbon tetrachloride extinguisher.
One 2½-gal. Foam extinguisher.
Two 1-qt. Carbon tetrachloride extinguishers.
See also the water hydrants on Fig. 3.

Oil Storage and Handling—A tank for oil, of sufficient capacity to empty a transformer or a three-phase oil circuit breaker, is provided. Pipes are run to a point near the transformers and circuit breakers where temporary flexible connections can be extended to the units. Filtering is done with a movable filter press by circulating the oil from the bottom to the top of the operating unit or oil tank. Pumps for circulating the transformer oil and for emptying the circuit-breakers tanks are located in the substation building. Power outlets are provided at the racks for filter press operation.

Water—To avoid drilling a deep well, water is purchased from a rancher adjacent to the property and stored in a 26x26-ft. concrete reservoir of 30,000-gal. capacity. Pressure for sprinkling system, fire and irrigation is obtained by using a motor-driven multiplex centrifugal pump; capacity of pump being 120 gal. per min. against 150-ft. head.

Water for domestic purposes is supplied from the main reservoir through a 200-gal. home water plant thus assuring pressure independent of fire and irrigation pump.

Battery and Charger—The battery used at this substation is rated 32 volts, 80 amp.-hr. The charging equipment consists of a motor-generating set, the motor of which is a ¾-hp., 220-volt, 50-cycle, 3-phase, 1,450-r.p.m. induction type. The generator is rated at 0.4 kw., 40 volts, 10 amp., 1,450 r.p.m., and is shunt wound. A switchboard for this charging equipment consists of a voltmeter, 0 to 50-volt range, and an ammeter with a zero-center scale, range 0 to 30 amp. An a.c. low-voltage coil which also controls the d.c. circuit is incorporated as part of the switchboard equipment.

Telephone Equipment—The telephone board used at this substation for connection to the company's private system is of the standard dead front panel type which has been adopted for substation use by the Southern California Edison Company. An insulating transformer is provided so as to minimize the possibility of high voltage getting on the telephone equipment in the substation. Additional protection is provided by small telephone fuses and arresters. At this particular station no telephones are provided for connection to the public telephone system.

Electrical Ground System—Reference should be made to Fig. 8, showing the ground system used at this station. The system used here has been adopted as standard and, as may be seen, consists essentially of a network of copper conductors throughout the property and this network connected to a ground well. In addition copperweld pipes are driven at a number of points throughout the substation property and the ground network attached thereto. All water piping also is connected to this network. It may further be seen that the lightning-arrester equipment is provided with its own ground system of driven pipes which is in turn connected to the station network. It is felt that by this practice of installing a network, and of grounding all of the electrical equipment as well as the water piping to this network, the safest possible ground is established. The chances for this electrical ground remaining effective throughout the life of the station is greatly enhanced. It also should be mentioned that experience has shown that it is advisable to ground the steel towers to the network, as carried out at this particular station.

Alarm System—The alarm system used at this station consists of a combination of a special annunciator, developed by the engineering department of the Southern California Edison Company, and the standard type of red and green signal lights used on all switchboard installations. This annunciator consists essentially of standard relays which are used to control current to lights covered with clear glass lenses

and to operate an alarm when certain equipment operates, as follows:

1 light to indicate a 60-kv. switch out.
1 light to indicate a 15-kv. switch out.
1 light to indicate a 4-kv. switch out.
1 light to signal when the starting compensator of the motor driving the oil pump has kicked out due to low voltage or loss of power. The two compensators for the two oil circulating pumps have pallet switches connected in series so that a signal is indicated when both are in the "off" position.
1 light for transformer temperature alarm, operated by contacts on the dial thermometer with which each transformer is provided.
1 lamp to indicate a ground on any of the circuits radiating from the 15 kv. bus. This particular signal operates in conjunction with the 15 kv. ground detector.

At the time a signal is indicated on the annunciator, an alarm also rings in the substation as well as in the relief operator's quarters and, the cottage of the operator. A push button on the annunciator is used to open the locking relay circuit to stop the bell alarm. Whenever the annunciator shows a light and rings the alarm in the case of a 60-kv. or a 15-kv. switch operation, the green signal on the switchboard indicates which switch is out. It should be mentioned that there also is a pilot light on the annunciator to indicate that d.c. power is available and ready to flash the signal and ring the alarm if necessary.

Lighting System and Emergency Lights—The lighting system and the emergency lighting equipment in the substation is as follows:

1. In the office, two 75-watt lamps operating normally on a.c. and one 100-watt lamp operating on d.c. when the a.c. is off.
2. Outside of the office, five 75-watt lamps on a.c. and two 100-watt lamps on emergency d.c. All lamps are provided with suitable reflectors. On both the 60-kv. and 15-kv. racks the emergency lights are in the form of standard spotlights so that the rack is illuminated sufficiently for the operation of disconnecting switches.

Conduit and Underground System—The conduit used consists of 2½-in. fiber laid in concrete, and the cable consists of multiple-conductor leads of No. 10 and No. 8 stranded, rubber-covered wire incased in a lead sheath. In all of the modern generating plants and substations of the Southern California Edison Company the policy of using fiber or iron conduit and lead-covered cables for control wiring has been adopted. It is felt that the use of lead-covered cable amply justifies the slight additional expense in that there is considerably less likelihood of the control cable becoming grounded and probably causing serious and costly incorrect switch operations.

Los Angeles Gas & Electric Corporation Substation No. 14

By F. E. DELLINGER

Substations of this design are used in apartment-house and outlying business districts for a.c. only.

Building is 50x90 ft., two floors; operator's cottage and garage on street-end of lot.

First Floor—Transformers, 2.4-kv. breakers and regulators.

Second Floor — High-tension buses, breakers and switchboard.

16.5 kv.

(a) Pipe frame work, double bus.
(b) Transformers: self-cooled, single-phase; in banks of 5,000 kva.
(c) Breakers: Kelman CB4, 400-amp., 33-kv., hand control.
(d) Induction-type O.L. relays and directional relays. S.&C. arresters on roof or oxide-film arresters indoors. Transmission lines either overhead or underground.

2.4 kv.

(a) 2.4 kv., isolated delta.
(b) Double bus, double breaker; 2 single-phase regulators per circuit, 250-amp., 10 per cent, automatic.
(d) FK132A and FK35 breakers in concrete cells.
(e) Plunger-type relays.
(x) Breakers remote manual control.
(g) Station service from feeder.

Buildings

(a) Building reinforced concrete and brick.
(c) Five-room stucco bungalow, and garage.

Miscellaneous

(b) One exchange and one dispatcher's telephone, extensions in house.
(c) 4/0 net-work to water pipes.
(d) Alarm on storage battery.
(e) Emergency lights from 12-volt battery.
(f) All 2.4-kv. feeders out of station underground to point where part go overhead.
(g) Special attention to walks, lawns and shrubbery.

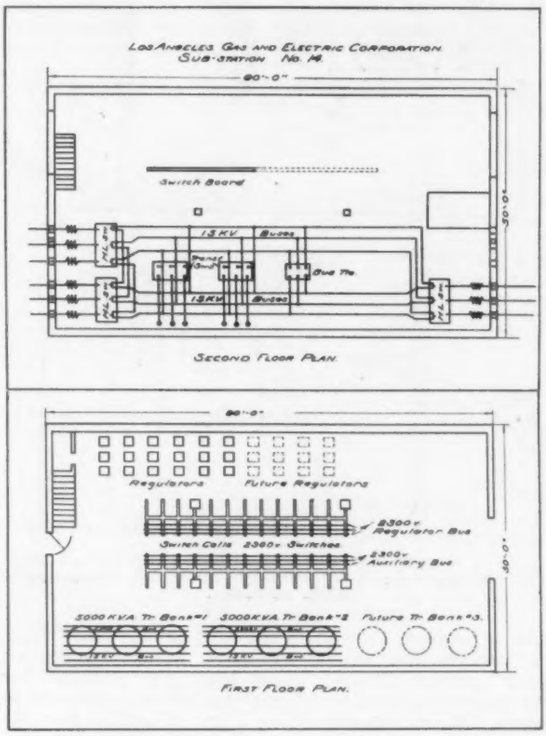


Fig. 1. Floor plans substation No. 14, Los Angeles Gas & Electric Corporation.

Los Angeles Gas & Electric Corporation Substation No. 10; 16.5/4 kv.

By F. E. DELLINGER

The following are specifications for a substation used in an outlying residential section.

16.5 kv.

(a) Pipe frame work, single bus.
(b) Transformers: self-cooled, single-phase; in banks up to 5,000 kva.
(c) Breakers: Kelman CB 4, 400-amp., 33-kv.
(d) S.&C. arresters on roof.
(e) Ammeters, voltmeters and wattmeter.

4 kv.

(a) 4-kv. Y, grounded-neutral, double-bus, double-breakers.
(b) Three single-phase regulators per circuit; 250-amp. 10 per cent, automatic.
(d) Breakers: FK132A, and FK35.
(e) Plunger-type relays.
(g) Recording voltmeter, neutral and ground ammeters.

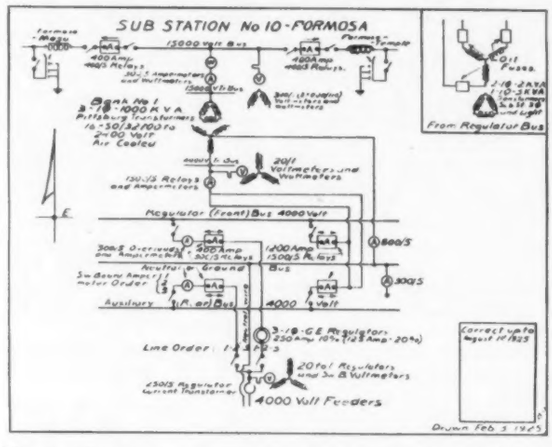


Fig. 1. Single-line wiring diagram Los Angeles Gas & Electric substation No. 10

Buildings

(a) Brick building.
(c) Five-room bungalow, and garage.

Miscellaneous

(b) One exchange and one dispatcher's telephone, with extension in house.
(c) 4/0 wire to water piping. Neutral to ground plate.
(e) Emergency lights from 12-volt battery.
(x) All circuits taken in from sub through iron pipe to poles.

Algoma Substation, The California Oregon Power Company, 60/2.3 kv.

By R. S. DANIELS

This substation was built to replace one that had become too small and that was in a poor location. The new station was placed in a more desirable location and the distribution circuits then cut over, causing an interruption of only short duration.

60 kv.

Structure: This is a wood structure with four 35-ft. treated poles set 5 ft. into the ground, supporting the necessary frame work on which is mounted one 66-kv., 200-amp., P.E.M. Co., type 1466 air-break switch with fuses, choke coils and ground gaps.

Transformer: Three 333-kva., 60-cycle, W.E.M. Co. 34.6-60 Y/2.3-kv., oil-cooled, outdoor type.

2.3 kv.

The 2.3-kv. equipment is all indoors.

Circuit Breakers: The three 2.3-kv. feeders are equipped with 400-amp., 4.5-kv., Westinghouse type F-11, full-automatic, remote-control, hand-operated oil circuit breakers mounted on pipe framework. The breakers control two power and one lighting circuit.

Disconnectors There are four sets of three disconnecting switches. One set of 600-amp., 7.5-kv. S.P.S.T. Westinghouse type S disconnecting switches between the transformers and switchboard bus and three sets of 400-amp. 7.5-kv. S.P.S.T. Westinghouse type S disconnecting switches between the bus and each oil circuit breaker.

Switchboard: The board of three black marine-finished slate panels, 16x65 in. with subbase 16x25-in., each panel having current transformers, ammeters, ammeter switch, etc. In addition there are three watthour meters with maximum-demand attachments, one recording the total output of the station and the others the output on each of the power feeders. Two potential transformers supply the watthour meters as well as one voltmeter.

Lines: All 2.3-kv. lines enter and leave the building overhead through 6.6-kv. wall bushings.

Buildings

The substation building is wood-frame covered with corrugated galvanized sheet iron. The size is 14x16 ft., with 9½-ft. walls. The floor is wood.

Miscellaneous

Fence: The station yard is fenced with 6-ft. woven-wire fencing having one 12-ft. driveway gate. The station is unattended.

Los Angeles Gas & Electric Corporation Substation No. 12

By F. E. DELLINGER

This substation is of a standard design, furnishing a.c. and d.c. in the downtown congested district. The building is 60x150 ft. and has three floors. The first floor has the transformers, motor-generator sets and d.c. feeder breakers. The second floor has the 2.4-kv. equipment and the third floor the transmission buses and circuit breakers. The control board and station auxiliaries also are on this floor. Circuit breakers are remote solenoid control and all circuits are underground.

16.5 kv.

(a) Frame work is of pipe. Double-bus system with single circuit breakers.
(b) Transformers: self-cooled, single-phase; in banks of 5,000 kva. High-tension for transformers is carried from third floor to first floor in concrete ducts which open through roof, providing ventilation for transformers.

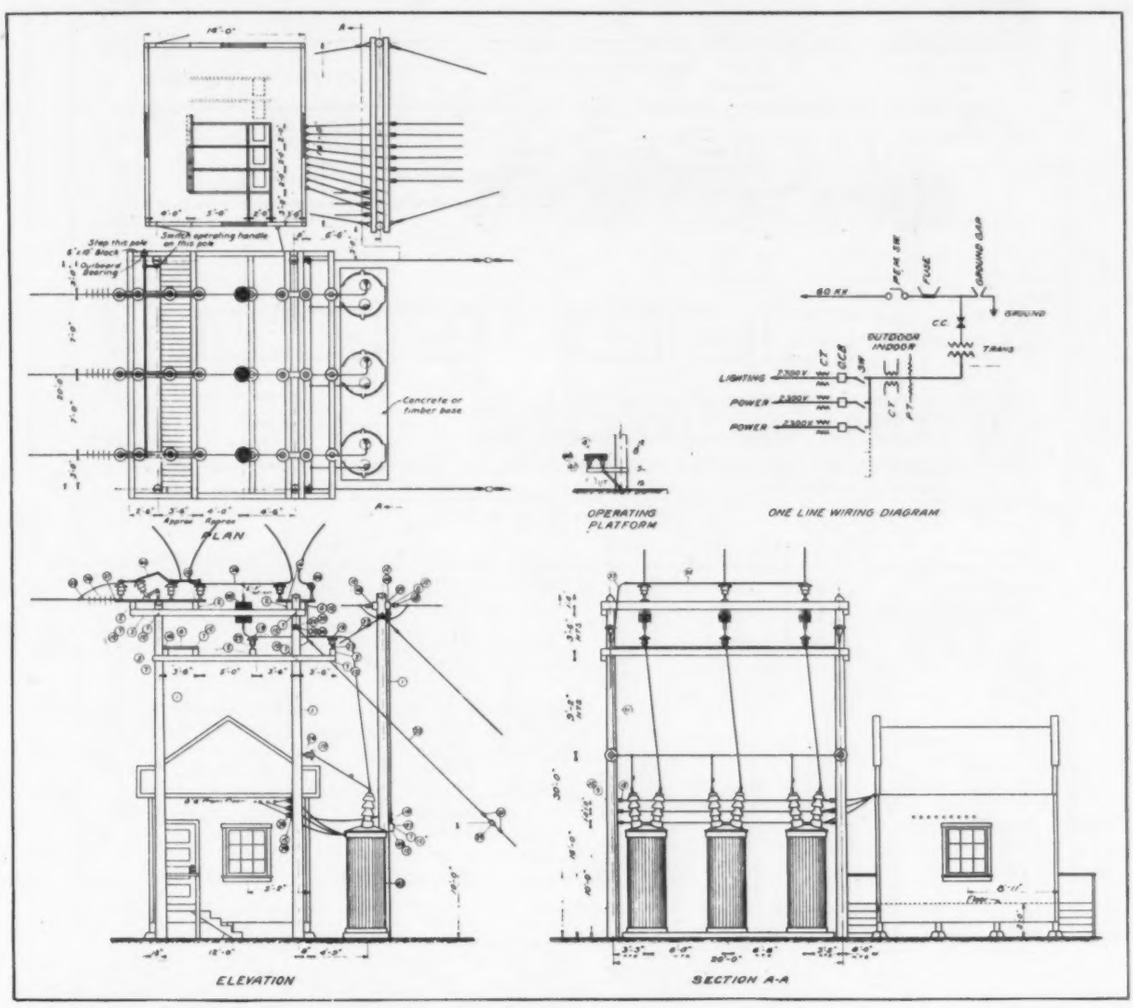


Fig. 1. Station details Algoma substation.

(c) Circuit breakers in concrete cells are Kelman CB4, 400-amp., 33-kv.
(d) Directional relays used on incoming high lines, and overload relays on outgoing high lines and transformer banks. Indoor oxide-film arresters used.
(e) Ammeters and voltmeters are used on high lines. Each transformer bank has ammeter, voltmeter and wattmeter.
(x) No automatic reclosing equipment used.

2.4-kv. Isolated Delta

(a) Double bus through single breaker in concrete cell, and regulator. Emergency bus to which any circuit can be switched for work on regulators or breakers.
(b) Two single-phase regulators on 3-phase circuit; 250-amp., 10 per cent buck or boost, automatic control.
(d) Breakers: FK132A.
(e) Plunger type relays; no arresters.
(x) Ammeter and voltmeters on each circuit.

250-125-Volt d.c.

(a) Double bus through single breakers.
(b) M.G. sets; 1,000 kw. each.
(c) Feeder breakers: SA1 or SA2, mounted on channel iron.
(d) Motors have plunger-type relays for overload and no-voltage protection. Generators have overload and reverse-current, and no-voltage protection. Feeders have plunger-type overload relays.
(e) Wattmeters on both motor and generators.

Buildings

Building is of reinforced concrete, brick and stone trim.
5-ton, man or oil hoist on third floor.
10-ton crane on second floor.

Miscellaneous

(a) 240-amp.hr. lead battery with 7-kw. M.G. set. Trickle charging is used.
(b) One regular exchange telephone and one dispatcher's phone.
(c) Water piping.
(e) Emergency lights burning all night from battery.
(h) Tetro chloride extinguisher.

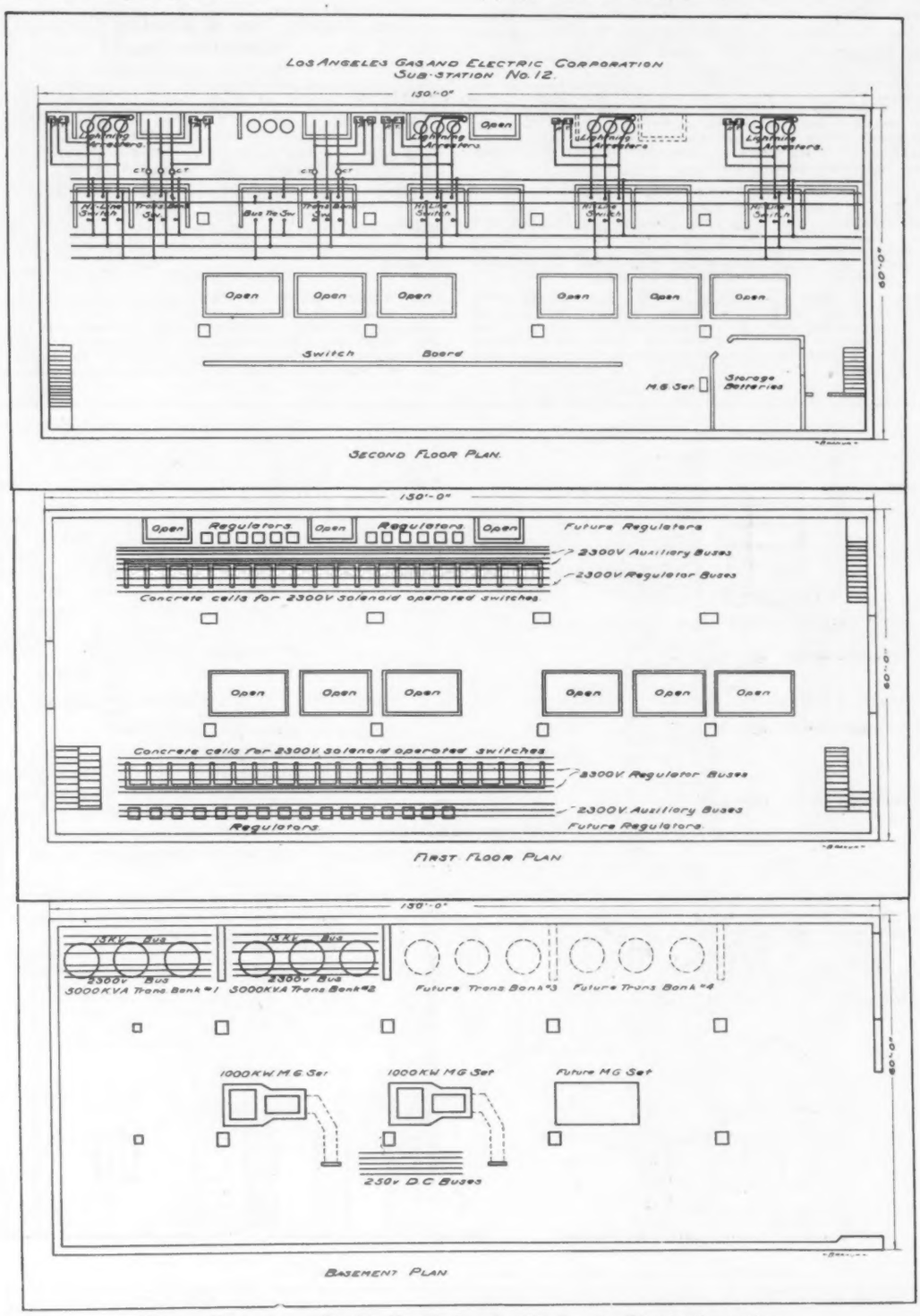


Fig. 1. Floor plans substation No. 12, Los Angeles Gas & Electric Corporation.

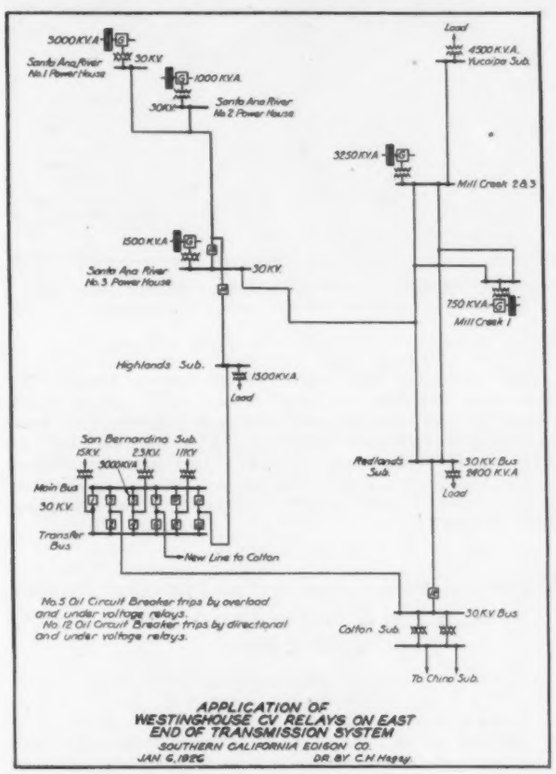
Relays and Relay Applications*

Specific instructions received by the relay subcommittee were to watch for, investigate and report all new or unusual applications of protective relays on the Pacific Coast. This assignment was considered to be sufficient inasmuch as existing practices of Pacific Coast companies in respect to relay application have been brought up to date in previous yearly reports of this committee. The report of the committee therefore consists of the three papers following.

Application of CV Low-Voltage Relays on the Southern California Edison System

By E. R. STAUFFACHER

As a means of isolating a certain portion of the system of the Southern California Edison Company at the time of system disturbances, use has been made of CV relays at certain strategic points with considerable success up to this time. While system distrubances are comparatively rare on the system of the Southern California Edison Company certain of these disturbances would have affected the whole system provided there was no means of isolating the above-mentioned section. This specific portion is the San Bernardino-Redlands district. Generating capacity in that territory and the load demand are so balanced that after such isolation the section can operate as a separate generating, transmitting and distributing unit for a comparatively short period, such as from one-half to one hour.



Schematic diagram of the eastern end of the system of the Southern California Edison Company showing points of application of selective separation.

Fig. 1 shows the system set-up on the east end of the transmission system. From it may be seen that the relay set-up is such that the hydro plants, Mill Creek No. 1 and Mill Creek No. 2 and No. 3, and Santa Ana River No. 3 are arranged to handle alone automatically the load demand of the Redlands substation and the Yucaipa substation. The power plants Santa Ana River 1 and 2 are so connected as to handle the 2.3-kv. load out of San Bernardino substation and the total load out of the Highlands substation at the time of system trouble.

CV relays are installed to operate switch 12 at Colton substation and switch 5 at San Bernardino substation. It may be noted that switch 12 referred to connects the Colton substation and Redlands substation together by means of a 30-kv. line, whereas switch 5 at San Bernardino substation is one of the transformer switches connected to the double 30-kv. bus at San Bernardino. Under conditions of normal operation switch 12 at Colton and switch 14 at Santa Ana River 3 power house, are both closed, while switch 13 is open at Santa Ana River 3. At the time of a system disturbance then, from the standpoint of the Redlands and Yucaipa load, switch 12 will open by the action of a CV relay, leaving that portion of the system isolated from the remainder and carried by the power houses already referred to.

In the case of San Bernardino substation, under normal operating conditions switches 1, 3, 4, 5, 9, and 10 are closed, leaving switches 2, 6, 7, 8 and 11 all open at this substation.

At the time of system trouble switch 5 at San Bernardino is opened by means of a CV relay, leaving the 2.3-kv. load, amounting to approximately 3,000 kva., to be handled by Santa Ana River 1 and 2 power houses. In addition to that load the load out of Highlands substation, consisting of approximately 1,500 kva., also is carried at times of trouble by these plants.

This scheme has worked out quite satisfactorily and has had occasion to operate several times in the case of Colton substation and one time in the case of the San Bernardino substation. It must be understood that these CV relays are used in addition to the usual overload and directional protection ordinarily provided in a transmission network.

Operating Characteristics of Reverse Power Relays

By F. J. LAWSON

As has been previously reported the Pacific Gas and Electric Company has been using reverse-power relays for a number of years on all its major transmission lines. While the operation of these relays has on the whole been quite satisfactory there are some places on the system where the characteristics of the relays are such as to handicap their use. The places referred to are some of the primary or high-tension substations which are so located that their outgoing feeders and tie lines of 60 kv. or 100 kv. are of considerable length before reaching the distributing substations. At these points conditions are such that under more or less normal operation the power-factor angle in the tie lines or feeders sometimes varies from nearly 90 deg. leading to 90 deg. lagging. These are conditions that the existing forms of reverse-power relays do not meet with entire satisfaction.

To determine the characteristics and limitations of some of these relays tests were made in the Pacific Gas and Electric Company laboratory on a General Electric type IB-1 relay and on a Westinghouse type CR relay, the results of which are described in this report.

The principal difference between these two relays is that the IB has a resistor in series with the potential coil that produces a phase displacement in the current through the potential coil of about 40 deg. over that obtaining in the Westinghouse element, or in the General Electric element with resistor removed.

The effect of this resistor on the operation of the watt-element is shown in Fig. 1 where OI is the vector of line current in the current coil and oi (not to scale) is the vector of current in the potential coil with the space displacement of 90 deg., which is the position at which the two currents have the maximum torque-producing effect. If we consider the potential coil current as remaining in phase with ϕ the voltage vector takes the position OA (with no resistance in

* Report of the Relay subcommittee of the Electrical Apparatus Committee: Roy Wilkins, Pacific Gas and Electric Company, chairman; C. F. Benham, Great Western Power Company; H. H. Cox, L. A. Bureau of Power & Light; R. C. Denny, San Joaquin Light & Power Corporation; J. N. Keith, The Southern Sierras Power Company; H. S. Lane, Pacific Gas and Electric Company; H. L. Sampson, Southern California Edison Company; E. D. Sherwin, San Diego Consolidated Gas & Electric Company; E. R. Stauffacher, Southern California Edison Company.

series); OA being made up of the IR component OA^1 and the IX component A^1A. Thus the angular position of OA and OI for maximum torque is with the current I leading the voltage by 7 deg.

With a resistor of 250 ohms in series with the potential coil and the same applied voltage of 110 volts the voltage vector takes the position OB, the angle between current and voltage for maximum torque being 34 deg. With 500 ohms series resistance the voltage is OC and the angle is 51 deg. current leading.

A similar diagram for the Westinghouse type CR relay is shown in Fig. 2.

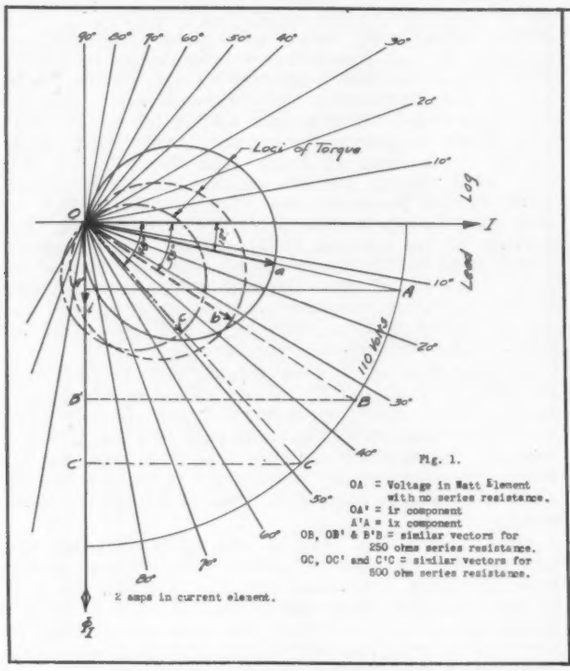


Fig. 1. Torque characteristics of watt-element of Westinghouse type CR relay.

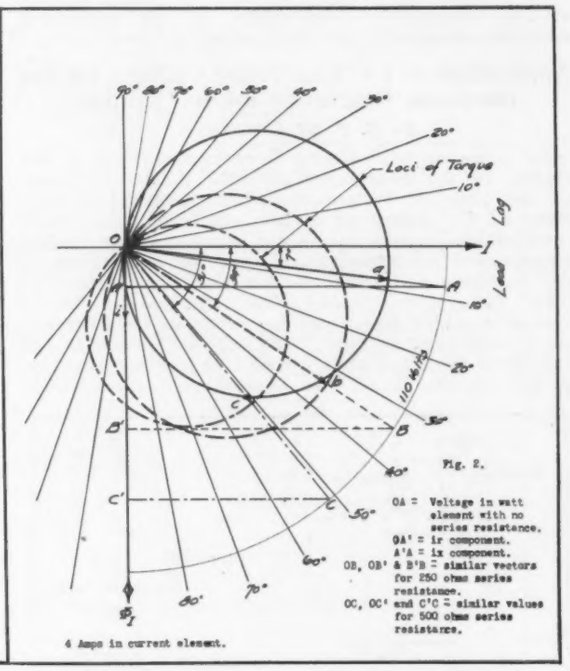


Fig. 2. Torque characteristics of General Electric type IB-1 relay.

If we plot the torque on the disk for varying power factors we find that the locus of the torque vector follows a circle which has its diameter on the vector of voltage. This, of course, is to be expected from the construction of the diagram since the torque is proportional to the cosine of the angle between the currents producing it. The torque circles shown were plotted from test data in which the torque was measured as the reciprocal of the time required for the disk to make a complete revolution; the contact and controlling spring having been removed previously. The decreasing size of the circles for higher series resistance is due, of course, to the decreasing current in the coil.

Limits of power factor within which the relay will reverse satisfactorily upon reversal of current are from about 60 deg. or 70 deg. on either side of the angle of maximum torque, giving a range of from 120 deg. to 140 deg. Beyond these limits the torque is too weak to be dependable and is reduced further in direct proportion to the drop in voltage. From the diagram it is obvious that the relay can be made to develop its maximum torque over quite a range of power factors by changing the value of the series resistance or by selecting currents and voltages at from 30 deg. to 90 deg. phase angles from delta-Y transformations, depending on what the probable power factor condition is at the time the relay is required to operate.

The General Electric Company in supplying its relay with the high value of series resistance recommends that they be so connected that at unity power factor the current will be 90 deg. ahead of the voltage. Under this condition the relay will develop maximum torque when the power-factor angle reaches 40 deg. lagging.

The Westinghouse company supplies its relay without series resistance, recommending a 30 deg. displacement between current and potential. This makes the relay develop maximum torque at approximately a 20 deg. angle, corresponding to a power factor of 0.93.

This company has found on its system that faster and more reliable relaying results with an in-phase connection of current and voltage. Hence this connection now is used on all its installations, but an attempt is being made for the locations mentioned where the power factor varies so widely, to develop a relay which will produce a torque less dependent upon power factor.

Protective Relay Practice of the San Joaquin Light & Power Corporation

By R. C. DENNY

Protective relays on any extensive transmission system play fully as important a part in the rendition of continuous, satisfactory service as any other class of apparatus on the system. Being automatic and selective they are infinitely quicker and more accurate than the average good operator. Moreover, they require little or no attention on the part of the operator while much of the ordinary station apparatus requires considerable attention. The automatic relay therefore is a great boon to the operator as it relieves him of the worry of outside troubles over which he has no control and allows him to concentrate on the station apparatus of which he does have control. It is not to be inferred from the foregoing that the relays do not require any attention. However the attention is more of a supervisory nature than of actual mechanical adjustments.

Obviously the proper selective action of relays on an interconnected transmission network depends largely on the proper current and time settings, but is somewhat influenced by changes in the power sources that sometimes occur incidental to seasonal operation of plants. The one-line map, Fig. 1, shows such a system and its various sources of power. In the 40 substations and plants of this system there are 95

transmission switches that are automatic and practically all equipped with bushing-type current transformers which operate induction-type relays. It readily may be seen that this system is composed of some 10 interconnected loops. These are normally operated all together to give greater system stability and provide two or more sources of power for most of the substations.

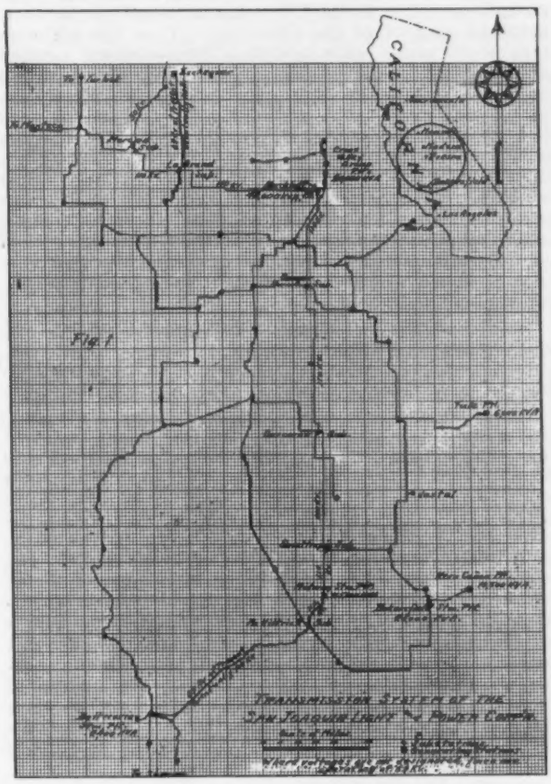


Fig. 1. Transmission system of the San Joaquin Light & Power Corporation. Where voltages are not designated, lines are operating at 69 kv.

In order that the relays shall have the proper current and time settings to function selectively and without causing unnecessary interruptions it is necessary to make a co-ordinated study of the system short circuit characteristics. This probably is best accomplished by ascertaining the reactance (ohms) values of all generators, station transformers and transmission lines as referred to some common voltage basis and then building up a miniature low-voltage system using resistance units of value proportional to those of the various line sections and generating units. System short-circuits may be simulated on this miniature system, the currents measured, the kva. calculated to within close approximation of actual system values and the relays set accordingly. Such miniature systems are commonly known as calculating boards or tables and one of these has been in service on the San Joaquin system for well over a year.

There is shown in Fig. 2 a family of decrement curves for such a system as that of the San Joaquin Light & Power Corporation, which has an average system reactance of 62 per cent. The curves shown are for 3-phase short-circuits. For single-phase shorts the current values are approximately 1½ times as high while for grounds they are about 2½ times, the grounded neutral connection being employed the system over. Owing to the fact that most of the line troubles are grounds or single-phase and that the current value drops off so rapidly for short delays it is necessary to resort to rather high current settings and comparatively low time settings, tapering both to get selectivity between stations.

All of the loop substations and plants have their switches equipped with the standard CR directional, overload relays connected to trip the switches for excess current in the outgoing direction in all cases; that is, away from the station bus. With reference to phase relations the relays are connected so that under normal operation and power-factor conditions the current in each relay leads the potential by 30 deg. This is recommended by the manufacturer and is found to be quite satisfactory. The potential for the relays is taken from star-connected metering transformers on the station secondary or distribution bus, employing

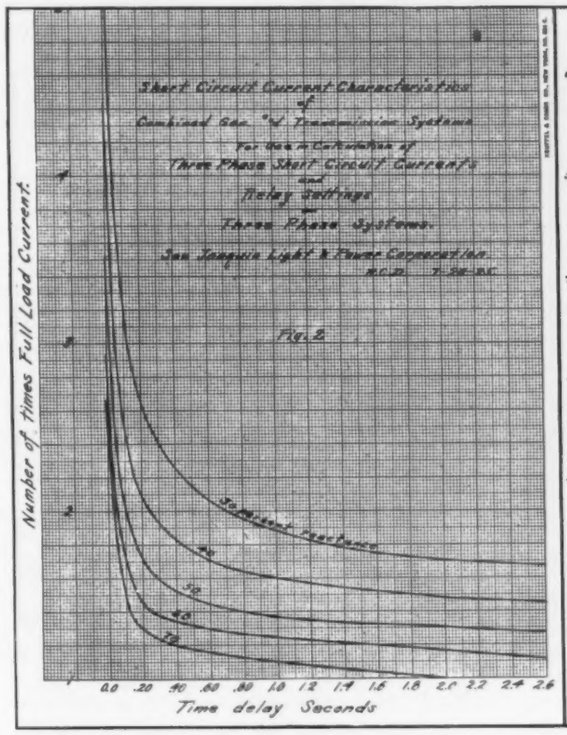


Fig. 2. Short-circuit characteristics of combined system, San Joaquin Light & Power Corporation.

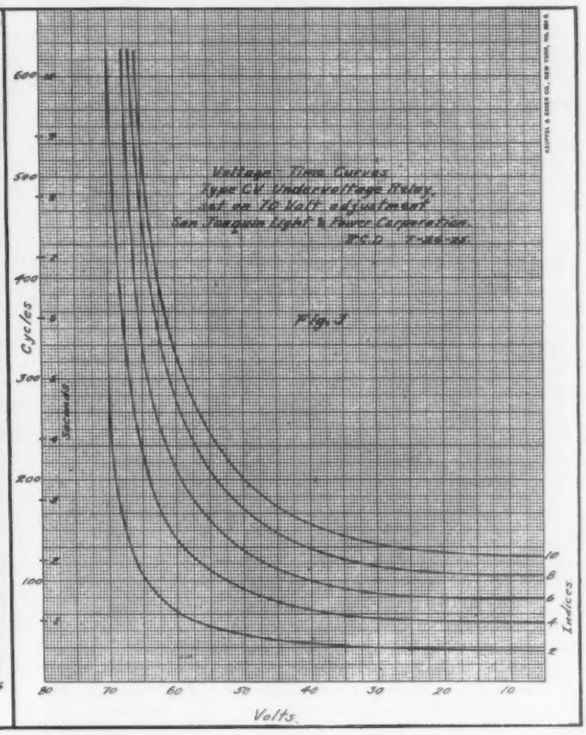


Fig. 3. Voltage-time curves of CV undervoltage relays on San Joaquin Light & Power System.

half taps in a delta connection to get the right voltage and necessary phase shift for the relays, the current being taken from star-connected bushing-type current transformers.

As inferred in a preceding paragraph the selective operation of the CR relays on grounds and single phase troubles is highly satisfactory. Time after time the bad section of line is dropped from service with only a momentary dip in voltage and very little effect on the system as a whole. For 3-phase shorts, however, the action is not so good. The relays show an appreciable drag even on the 60-kv. system where the current is greater for any given kva. Even worse action has been experienced on the 110-kv. system when the relays have not worked at all on the few occasions of 3-phase shorts. It will be evident from Fig. 1 that the 110-kv. line really is the backbone of the system extending eventually to the Coast. Obviously then, this should be the most reliable line of the system from all standpoints and 3-phase shorts occurring on this line, seldom as they do, should not be allowed to demoralize the entire system.

Inasmuch as the current falls so rapidly to low values on 3-phase shorts, as is evident from the 60-

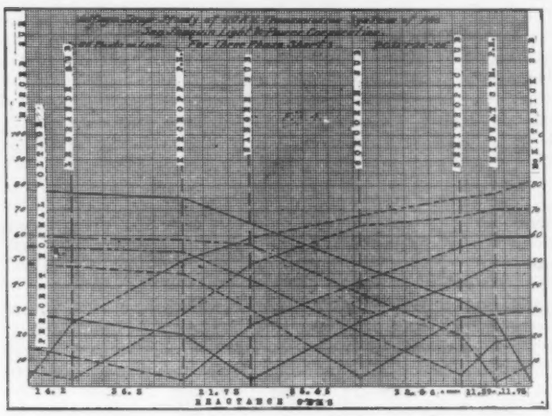


Fig. 4. Voltage-drop study of the 110-kv. transmission system of the San Joaquin Light & Power Corporation.

per cent reactance curve in Fig. 2, it is no great wonder that the 110-kv. system relays do not get enough current to operate. Recognizing the voltage drop on such occasions as offering a possibility for the application of a relay to operate irrespective of current values an investigation was made of the characteristics of the CV under-voltage relay. This is a standard induction-type relay much resembling the better known CO relay, but having a potential winding instead of a current winding. By means of an induction regulator and cycle counter the curves of Fig. 3 were derived. The inverse time characteristics are very similar to those of the overload relays and are all that could be desired. Different voltage adjustments have little or no effect on the shape of the curves, merely shifting them one way or the other along the horizontal axis.

In order to arrive at the proper voltage and time adjustments of the CV relays at the points of application on the 110-kv. system a study was made of the voltage-drop situation for 3-phase shorts at the various points. This is presented graphically in Fig. 4, giving the voltage drop as a percentage of normal. This is done on account of the varying transmission bus voltages at the stations concerned and the impossibility of maintaining a uniform transmission voltage level. This study was made on the system calculating board and checks very closely with actual results as observed at several stations during 3-phase shorts. It has been found through a correlation of the results of these studies that by using the proper voltage and time adjustments on the standard CV relays it is possible to get about 40 cycles' time between stations with a minimum definite time of 2 sec., which is manifestly better than no operation at all.

Thus it is possible to get selective inverse time protection against 3-phase shorts without a current-actuated element. The scheme would be of little value in a loop system without the directional feature. This is secured by combining the CV relay with the existing CR relays in such a manner that the trip-circuit contact of the CV relay shunts the current-actuated contact of the CR relay. Thus the CV contact is in series with the directional-element contact of the latter. This is done as shown in Fig. 5 where an extra stud is brought out on the CR relays connected as shown. An auxiliary relay is used to keep the special connections on the CR relays separated until the CV actually operates. This is to prevent improper operations that might occur during grounds or single-phase troubles where one relay of the opposite set of CR's would close its overload contact while the directional contacts of the other two relays of the same set were closed for normal power flow in the opposite direction which would result in the wrong switch tripping.

It may even happen that a CV relay down the line may function on a single-phase or 3-phase short several line sections away, however, so as not to trip its switch owing to the direction being wrong. Ths will be made apparent to the operator through the operation-indicator target on the CV relay, and he will immediately reset the auxiliary relay, no harm being done at all. If some other ground or single-phase short should occur while this condition existed there still would be the usual CR protection. It may be noticed that only one potential transformer is necessary, all CV relays at one station being connected to the same transformer. Inasmuch as the scheme is for 3-phase short-circuit protection under which conditions all phase voltages collapse similarly it makes no difference which phase of the station bus this potential is connected to. In fact the existing synchronizing transformers are used to save additional expense. If the CV relay functions for single-phase trouble on the particular phase to which it is connected, it tends only to assist the CR relay in getting the line out. This is not objectionable.

It will be apparent, therefore, that such a scheme in itself gives adequate protection against 3-phase shorts and at only slight additional cost over the CR installations, providing that line synchronizing potential transformers are in service, which they usually are. While 3-phase shorts may occur rather infre-

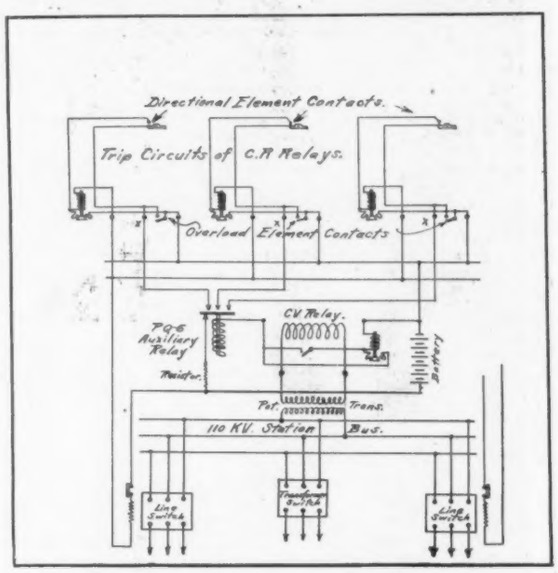


Fig. 5. Connections for combining CV relays with CR installations; "x" stands for extra terminal connection.

quently it is believed that the protection afforded by the scheme outlined is a good, cheap insurance against shut-downs and therefore is entirely justified.

Operating Experience with Oil Circuit Breakers*

In order that the findings of this subcommittee might be of as much practical value as possible the work was directed along the line of actual operating experiences. In the past there has been much said pro and con about the oil-switch situation from the standpoint of both manufacturer and operator. If the operator has not known his circuit breaker needs, then this fact alone is good and sufficient reason for the existence of such a subcommittee and for its aims. It is the purpose among the 12 operating companies comprising the membership of this subcommittee to analyze all transmission oil-circuit breaker operations, particularly from the standpoint of rupturing duty and to keep a record of same. In this way the performance of switches may be compared between systems and a more nearly satisfactory performance rating established. In order that the procedure be uniform the committee members last year agreed upon the information desirable for such study and a tentative report form was drafted. This since has been adopted in substance by the operating companies of the P.C.E.A.

Manufacturers' Ultimatum

Coincident with the activities of the operating companies along the line of oil-circuit breaker investigations comes the ultimatum of the manufacturers as set forth in the Electric Power Club Rule 10,692: "Manufacturers' published ratings of oil-circuit breakers are not guaranteed because these ratings presuppose that the oil-circuit breaker has been properly installed and maintained and that it is in efficient operating condition at the time of the circuit interruption; particularly as regards contacts, oil and mechanism, and those conditions are outside the control of the manufacturer." While this might be expected rather to offset the efforts of the committee it probably is a very good reason for continuing the work, if there really is cause for any apprehension. It is to be expected that the work will be somewhat discounted. However, the continuance of the circuit-breaker operating records is sure to be of value in that they will establish a more definite relationship between satisfactory breaker operations and the practice of inspection and maintenance.

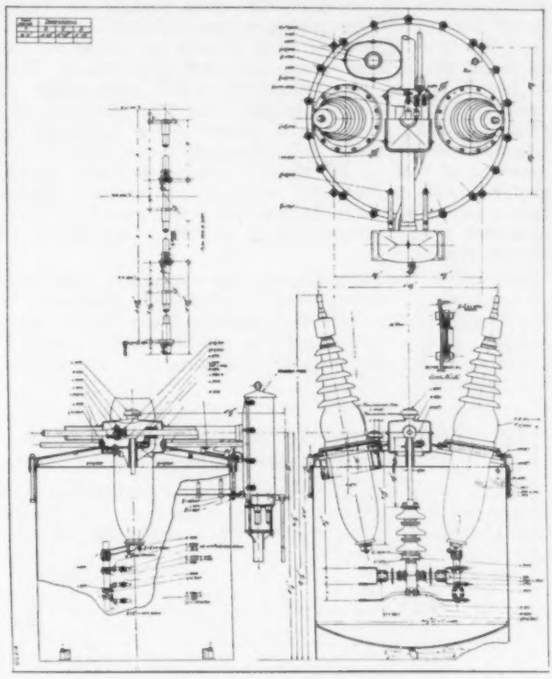


Fig. 1. Pacific Electric 110-kv. breaker, a typical design.

It is somewhat interesting to note from the breaker data submitted that the pioneer companies of the P.C.E.A. have on their systems a preponderance of locally built breakers. In fact one company has manufactured many of its own breakers. This might be expected, owing to distance from eastern maufacturing centers. It is very gratifying, however, to find that Pacific Coast circuit-breaker manufacturers are coming to the front and keeping pace with the advancement of the art. Standard 70-kv. and 110-kv. circuit breakers of the Kelman Electric Manufacturing Company of Los Angeles and the Pacific Electric Manufacturing Company of San Francisco are shown in illustrations accompanying this report. Both of these manufacturers seem rather in agreement that rupturing capacity is properly increased by additional breaks in series while each has a different method of obtaining that result. The Brown Boveri Company manufactures a breaker rather on the same order. However, at the present time none of them are in use among the P.C.E.A. companies while the Kelman and P.E.M. breakers are fairly well represented.

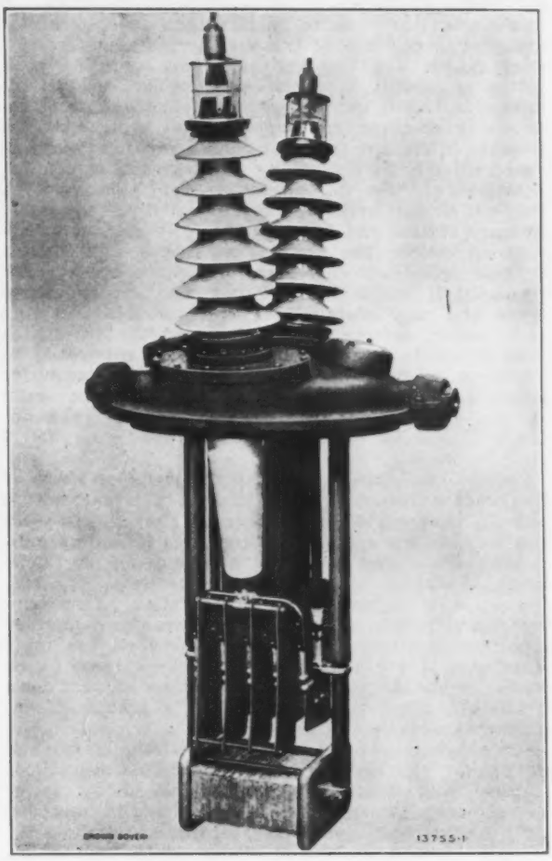


Fig. 2. Brown-Boveri 110-kv., 350-amp., single-pole breaker with tank removed.

Other breakers mentioned in this report and in use on Pacific Coast systems are the well-known designs of the Westinghouse Electric & Manufacturing Company and the General Electric Company. Both of these manufacturers adhere to the 2-break and resort to the quick-break arcing contact and the explosion chamber respectively to gain rupturing capacity. It is evident therefore that there is some difference of opinion among the manufacturers as to the proper method of gaining rupturing capacity. However, from the operators' viewpoint it is felt that the rupturing capacity of circuit breakers is dependent upon some five essential features of design, whatever the arrangement. These are

A For interruption of arc: Contact break distance; speed of contact travel; contact pressure; magnetic blow out effect.

* **Report of Subcommittee. R. C. Denny,** chairman. K. B. Ayres, C. F. Benham, H. H. Cox, R. S. Daniels, F. R. Knight, H. A. Laidlaw, C. C. Long, P. J. Ost, E. D. Sherwin, T. W. Snell, E. R. Stauffacher, W. R. Van Bokkelen, P. H. Yelton.

B For absorption of energy of arc: Volume of oil; oil head above contacts; air space above oil; venting.

C Mechanical strength: Strength required throughout to withstand the strains due both to pressures developed by release of gas and to electromagnetic effects of the heavy currents handled.

D Thermal capacity: All cunrrent-carrying parts must have sufficient thermal capacity to carry the maximum currents while they last.

E Oil quality

Meeting Operating Requirements

These requirements may be met satisfactorily in any make of switch if it is properly designed. It would seem therefore to be largely a question of the operating experience of the designer. This is yet another reason why the findings of an operating committee on circuit breakers could be of considerable value. In fact it is gratifying to note that during the current year there are improvements being made in several different makes of breakers that may be traced directly to the efforts of operating companies, members of the oil circuit-breaker subcommittee. The oil circuit breaker, subject as it is to extraordinary strains and blows, may easily get out of adjustment unless the design be simple and sturdy. If these misadjustments occur inside the breaker and especially if under the oil they may easily escape notice and may eventually lead to trouble. In fact such minor defects have led indirectly to switch failures which inadvertently have been attributed to failure to rupture, whereas the only good reason for failure to rupture is that the breaker is too small for the job. If breakers are to be properly maintained the inside mechanisms must be made fairly easily accessible.

Outside mechanisms are responsible for a share of the breaker troubles and while of a minor nature they often are quite exasperating. The trigger work that controls the operating energy, the levers, springs, weights, and pallet switches, are some of the little things anyone of which out of adjustment may prevent or delay a proper breaker operation. The trip-free characteristic of transmission breakers is a very important feature as it has a bearing on the relay situation. Where transmission breakers have to be closed by hand and the operation thus slowed down it often happens in closing in on a bad line that some other breaker down the line is tripped before the one being operated has been entirely closed and set up for the opening operation. This sometimes happens even when breakers are closed by power and operate faster, and usually results in unnecessarily interrupting some other substation.

While there probably has been more said about and less done about oil than any other phase of the breaker situation the fact remains that some oils give better service than others in circuit breakers. Whether there is any "best" oil for circuit breakers is problematical; at least it is dependent upon operating conditions and climatic conditions particularly. Some oils vaporize, volatilize and decompose readily so their use in circuit breakers obviously would be unwise although they might serve fairly well in transformers. Several of the operating companies are using transformer oil in their circuit breakers, particularly the General Electric No. 10-C transil oil. Others are using only such oil as recommended by the breaker manufacturer. One of the foremost breaker manufacturers advocates the use of transformer oil in circuit breakers while another prominent manufacturer deplores the practice. However, the latter manufacturer admits looking for an oil satisfactory for both purposes so the indications are good that the controversy may be short lived. Practically all the operating companies are content to accept their breaker oil on the agent's guarantee with no other test than that for dielectric strength. This seems rather unusual when one considers how exact the electrical engineers are in their specifications for the electrical apparatus intimately associated with oil.

Tests on oil as indicated by one of the N.E.L.A. questionnaires on the subject include the following items:

Specific gravity, 15.5/15.5 deg. C.
Flash test, deg. C. minimum.
Fire test, deg. C. minimum.
Pour test, deg. C. maximum.
Viscosity, seconds, indicate deg. C. maximum.
Demulsibility, c.c./hr. minimum.
Resistance to emulsification seconds maximum.
Moisture per cent maximum.
Sediment per cent maximum.
Turbidity.
Sulphur corrosion.
Sulphur per cent maximum.
Unsaturated hydrocarbons, per cent maximum.
Michie per cent maximum.
Evaporation per cent maximum.
Dieletric kv. minimum.
Color.

Duty Cycle

The subcommittee has not been particularly concerned with the reclosing duty-cycle for transmission circuit breakers. Operating practices vary so much in this regard that it would be practically impossible to hope to standardize on any uniform procedure. It develops that there is even some difference of opinion regarding the procedure of 3-phase short-circuit breaker tests. This, it might be said, resolves itself into the question of whether or not circuit breakers are actually bought on the basis of how much of a short they will close in on rather than how much of as hort they will rupture. The closing duty is thought to be unnecessarily severe as the arcing tips and blades have to withstand the fusing effect of the initial short-circuit current, whereas no breaker can open quickly enough to break the initial short-circuit current.

Some operating companies have so far departed from the Electric Power Club's "2-OCO" duty cycle as to use other breakers to test lines instead of using the one originally clearing the short. There also are numerous cases where a breaker manufacturer has departed from the same duty cycle by closing 3-phase shorts with another breaker in series with the breaker under test. These exceptions uphold the old saying that there are exceptions to all rules. The selection of oil-circuit breakers and the practice of subjecting them to short-circuit tests should be based somewhat upon the average service that they will likely get; at any rate they should be tested at the point on the system where they are to be used. This is borne out by the relatively small percentage of breaker failures, probably not over two or three per cent per year on systems experiencing hundreds of trip-outs each year. Any company that follows the practice of testing all their breakers at their system power-center undoubtedly will pay for a much higher factor of safety than is necessary for many of their breakers which will result in an over investment in circuit breakers.

Several of the larger operating companies have submitted circuit breaker reports which are presented in their entirety following this paper. Many of the other companies have expressed the intention of vigorously pursuing the work in order that they may know their breaker needs.

Oil Circuit Breakers on System of Pacific Gas and Electric Company

The following is a summary of the high-tension oil circuit breakers in use on the system of the Pacific Gas & Electric Company, classified according to voltage and manufacture:

60 kv.—	P.G.&E.	159	
	P.E.M. Co.	21	
	P.E.M. air and oil	15	
	Stanley	1	
	G.E.	17	
	Westinghouse	7	
	Kelman	2	
	N.C.P.	5	
	Total		227
110 kv.—	P.G.&E.	7	
	P.E.M.	4	
	G.E.	36	
	Westinghouse	20	
	Total		67
220 kv.—	Westinghouse		16
	Total		310

P.G. and E. 60-kv. Switch

As will be noted the very large majority of 60-kv. breakers are of the company's own manufacture. All of these are of the horizontal 4-break type with the

exception of a very few 2-break switches of an older design. The majority of these breakers are solenoid operated, the solenoid mechanism also being of company design. Fig. 1 shows the assembly of a recent design of this switch of which there are a large number in use.

Within certain limits these switches function satisfactorily, with a normal amount of maintenance of arcing contacts and attention to the oil. However, tests that have been made indicate that the speed of operation should be improved and that the construction of the rotating element which consists of porcelain insulators litharged into a revolving shaft is not mechanically strong enough. There is a tendency for the litharged parts to loosen allowing the shaft to turn independently of the blade assembly. In some cases the blade assembly has dropped to the bottom of the tank.

This trouble is believed to be caused to a considerable extent by the jarring of the rotating element when the contacts close, due to the bottoming of the

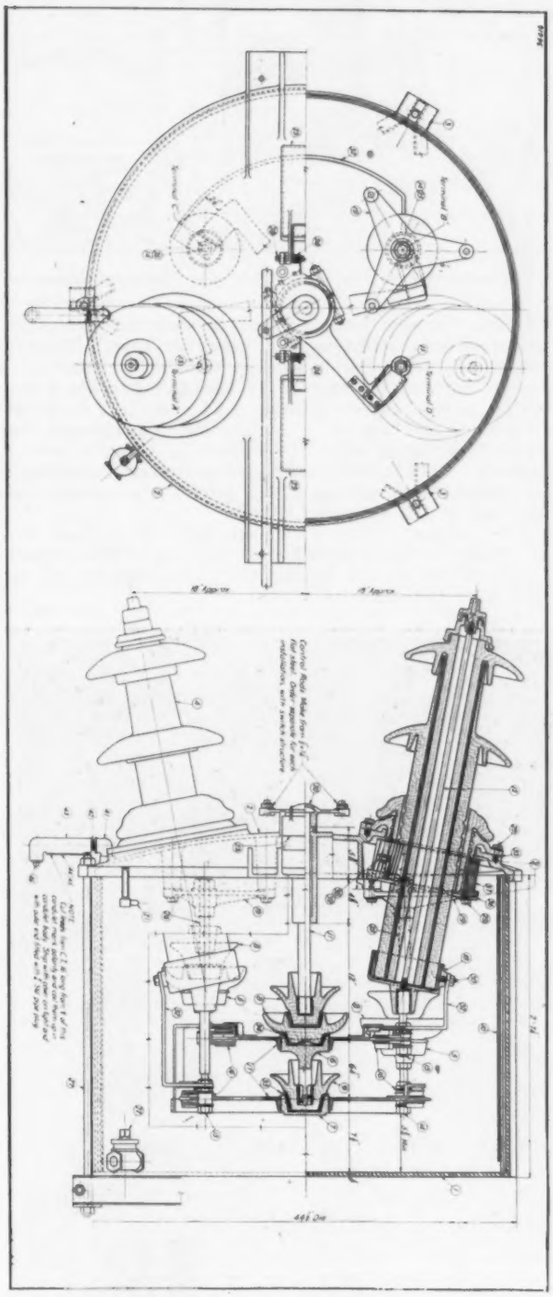


Fig. 1. A common design of circuit breaker as manufactured by the Pacific Gas and Electric Company

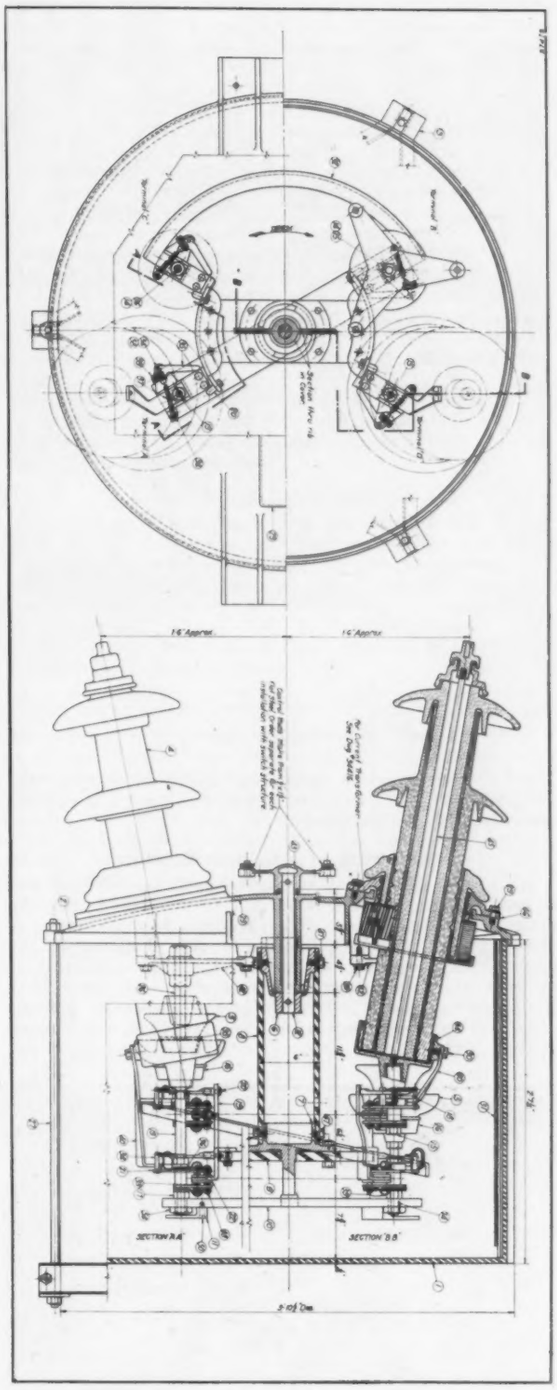


Fig. 2. A later design of the Pacific Gas and Electric Company circuit breaker.

plunger in the solenoid and to the inertia of the relatively heavy revolving parts. The construction is such that unless extreme care is taken in adjusting the central gear the revolving blade may pass through the stationary clips far enough to strike the stud supporting the same. This not only tends to lessen the revolving parts, but also to damage the bushing and destroy the alignment of the stationary contacts.

The bearing of the revolving element is carried in the top of the switch tank and is necessarily rather short. A small amount of lost motion in this bearing allows the lower end of the revolving shaft, carrying the moving blades, sufficient play that the blades cannot enter squarely into the contacts. The arcing tip projects some distance beyond the main contacts and is of more or less rigid construction so that

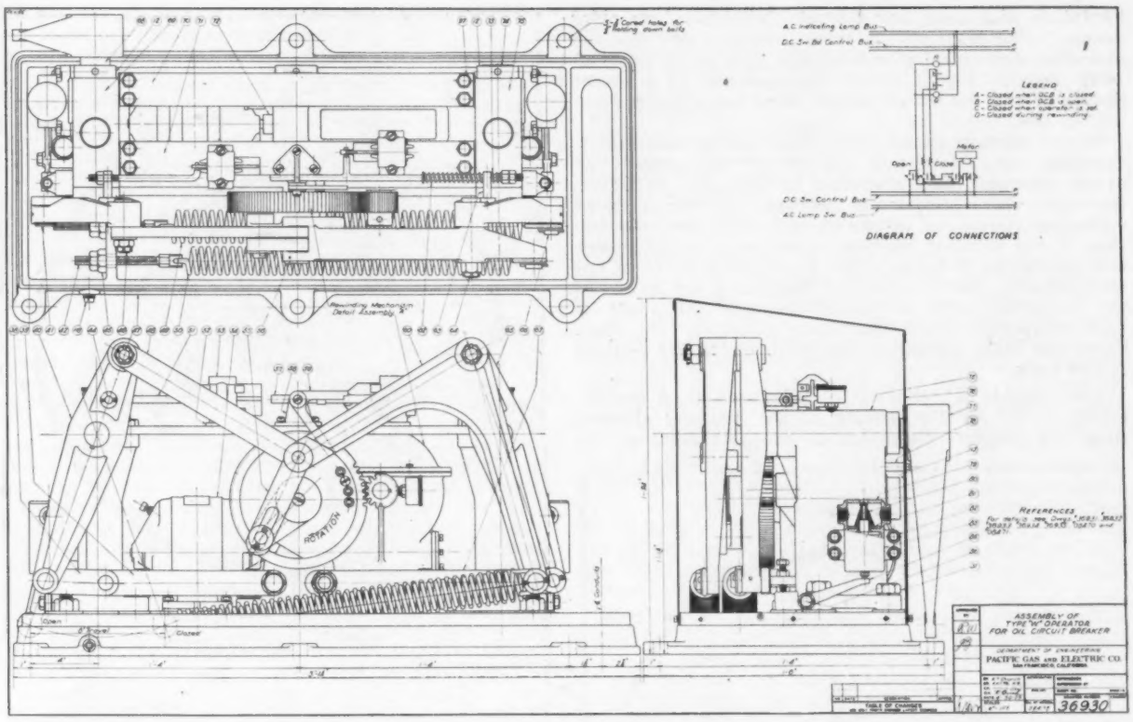


Fig. 3. Details of motor-driven operator for oil circuit breakers; manufactured by the Pacific Gas and Electric Company.

should welding occur upon the initial closing of the switch there is a possibility that the switch could not complete its closing stroke.

New Design of P.G. and E. Switch

All of the above matters were given some study and a new design prepared with a view to eliminating the difficulties mentioned. The result of this study is shown in Fig. 2 which is an assembly drawing of the new switch recently developed by this company, a number of which now are in service. To date they have proven satisfactory. They apparently possess considerably more rupturing capacity than the former switch, although the physical dimensions are identical. In fact, the new assembly can be installed in existing units without changing the tanks or tops. This increase in rupturing capacity probably is due to a change in the construction of the arcing contact providing a much quicker break. This contact is so arranged that there is a rolling motion between the contact surfaces when the switch is being closed or opened. Upon opening, the arcing contact is retrieved by means of a spring. This provides a considerable increase in the speed of break.

The rolling action described acts in such a way as to prevent the possibility of welding of the contacts upon closing which would cause the failure of the switch to complete its stroke.

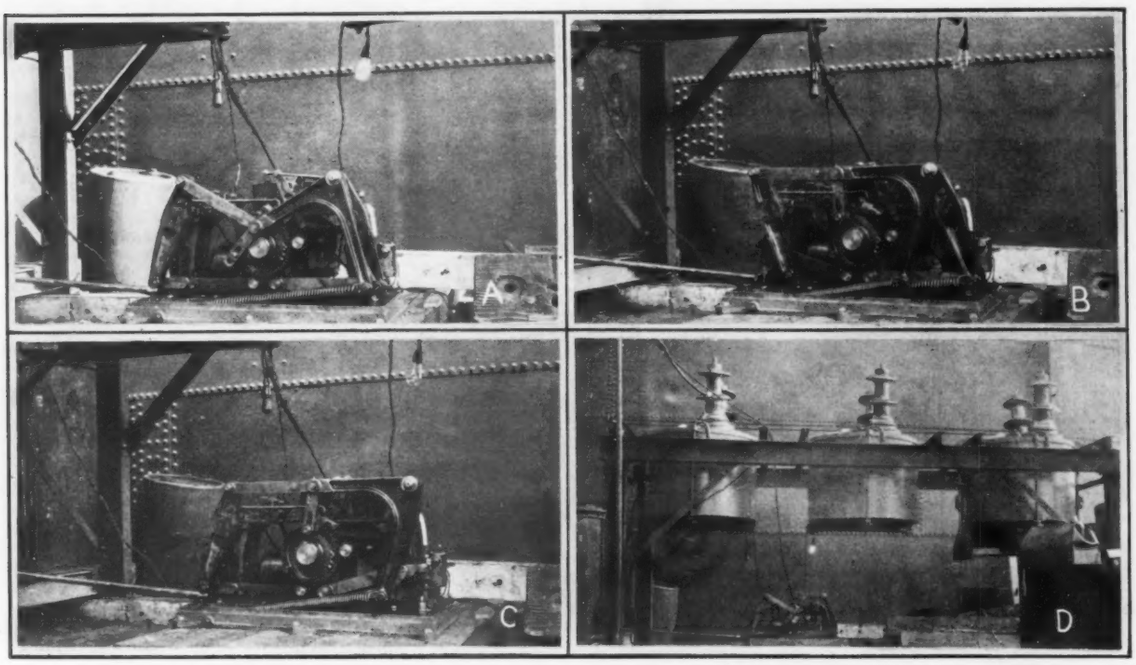


Fig. 4. Pacific Gas and Electric Company switch operator in service. (A) Both springs cocked, switch in open position. (B) Switch closed, tripping spring cocked. (C) Switch tripped, closing spring cocked. (D) Showing relative size of operator.

The arrangement of the main contacts still adheres to the horizontal 4-break scheme, but the contacts themselves are so designed that the blades can pass entirely through the contacts without striking the studs holding them.

An external stop for the mechanism is provided so that the blades normally will rest in the center of the stationary contacts when the switch is closed. The porcelain revolving element insulation has been replaced by a heavy Bakelite tube. A lower bearing provided for the revolving part also effected much sturdier construction.

Type W Switch Operator

A new spring-type operating mechanism, known as the type W operater, has been designed and constructed to replace the solenoid operator formerly used. An assembly drawing of this operator is shown in Fig. 3. In this operating mechanism springs under tension actuate the switch both in the opening and in the closing strokes. After the switch has been tripped a motor automatically winds up and latches both springs, taking about 7 sec. to perform this operation. As only a small motor is required to perform this duty the mechanism may be operated from a 24-volt storage battery, eliminating the necessity for a large battery with its attendant high initial cost and maintenance expense.

By increasing the size of the motor larger switches may be operated; plans are under way to operate 110-kv. oil circuit breakers by this method. The speed with which it is desired to reclose the breaker after it is open or, in other words, the time required to place the springs under tension governs the size of the motors used. The speed at which the breaker is operated is governed by the stiffness of the springs. In the standard operator, a ¼-hp. motor is used, requiring approximately 7 sec. to place the springs again under tension after the switch has tripped, as stated above.

Inasmuch as there are separate springs for the opening and closing function the breaker always is in a position to trip immediately after it has been closed. The mechanism is designed on a toggle principle so that the switch is locked in both the open and closed positions and the travel is definitely fixed by the straightening of these toggles.

OIL SWITCH OPERATING RECORD

Operating Company .....

Switch Location ..... Date ..... Time ..... A. M. P. M.

Company No. or Designation ..... Circuit Voltage .....

Manufacturer's Name ..... No. .....

Rated Voltage ..... Oil Used .....

Rated Current Capacity:—Carrying ..... Rupturing .....

Type of Switch—Automatic ..... Non Automatic ..... No. of Breaks .....

Nature of Overload—Ground ..... Single Phase ..... Three Phase .....

Approximate Current Interrupted .....

No. of Automatic Openings since Last Overhaul .....

Findings—		Phase A	Phase B	Phase C
External	Bushings			
	Tops			
	Tanks			
	Oil Spillage or Leakage			
Internal	Bushings			
	Blades			
	Contacts			
	Oil: dirty, wet or carbonized			

Was Opening Satisfactory .....

General Remarks .....

Fig. 5. Operating record form kept by Pacific Gas and Electric Company.

During initial tests made in the shop on this operator connected to one of the new-type switches described above, the combination was operated 7,000 times. At the end of that time no replacements of any sort or any major adjustments were necessary either in the switch or in the operator. Fig. 4 shows different views taken during these tests. The operator is shown (A) with both springs cocked, the switch being in the open position; in (B) the switch has been closed, and in (C) it has been tripped. A comparative idea of the size of the operator is given in (D). Under actual operating conditions no failures of this mechanism have occurred to date.

The speed of operation with the operator now in use is the same as with the solenoid formerly standardized upon. This is about twice the speed of operation of any gravity-operated switch. With the spring operator the speed can be increased by stiffening the spring.

Patents have been applied for on this device and negotiations for the right to manufacture it for general use are now being carried on with one of the Pacific Coast manufacturers.

Operating Experience

This company has instituted the use of the form shown in Fig. 5 for the purpose of keeping a record of operation of all high-tension oil circuit breakers at a number of selected substations. The use of this form has not been adopted at all of the substations on the system and it has been in use only about four months. Hence the data so far collected is not very complete.

However, Table I gives a summary of the results so far obtained by the use of this form, listing the total number of switches under observation, the number of satisfactory and unsatisfactory operations and the estimated maximum current satisfactorily interrupted. It is only fair to say that the two circuit breakers which did not operate satisfactorily were of an old and obsolete design that has not been manufactured for a number of years. They gradually are being replaced by a later type of switch.

Pacific Gas and Electric Company Switch-Record Summary

		60 K.V.		110 K.V.		220 K.V.
	P.G. & E.	Mfr. G	Mfr. P	Mfr. G	Mfr. W	Mfr. W
Number of switches under observation	87	11	10	23	14	16
Satisfactory operations	64	10	1	8	8	20
Unsatisfactory operations	2	0	0	0	0	0
Maximum Current Satisfactorily interrupted	3200	4000	910	1700	1600	525

Following are some of the difficulties which have been experienced in the operation of oil circuit breakers of types other than already described in the foregoing.

In the explosion-chamber type of breaker manufactured by one large company the removal of the fiber insulating tubes surrounding the explosion chamber and the removal of the bottom of the chamber is necessary in order that the stationary contacts may be removed for proper inspection. This means that the oil must be entirely removed from the switch and considerable preliminary work done before an inspection of the contacts can be made. The bridging of lamps across the bushings is not a good check on the condition of the contacts as the movable contact rods may bear heavily on one side of the stationary contacts due to slight misalignment. This would permit the three phases to close simultaneously, but would allow a severe burning of the sides of the arcing tips due to their making contact on only one side. The lamp method of inspection will give no indication of this condition and it is believed that actual visual inspection of the contacts is necessary at regular periods. This is made more costly than seems warranted, because of the amount of preliminary work necessary.

There is no trip-free feature provided in the control mechanism of this breaker, which is a serious fault. If the auxiliary closing relay fails to open through welding of the contacts or for any other reason, if the closing button be held after the switch

is closed, or if the closing circuit remain energized for any other reason the breaker will not trip even though the trip circuit is closed by the relays. In practically all other breakers a trip-free feature is provided in the mechanism itself so that in case a switch is closed on trouble it will trip out immediately even though the closing solenoid remains energized.

Other difficulties which have been experienced with this type of breaker have been heavy carbonizing of oil in the explosion chambers and the misalignment of the moving contacts due to warping of the wooden parts in the moving contact assembly. This latter is practically impossible to prevent. Trouble of this sort can be prevented only by rigid and frequent inspection.

With the butt-contact type of circuit breaker manufactured by another large concern the principal difficulties experienced have been due to failure of the quick-break mechanism to latch and the difficulty of maintaining an adjustment which will allow all latches to disengage properly and simultaneously. Failure of the latching mechanism to operate properly is due not directly to the interruption of large currents but is inherent in the design and caused by loss of adjustment due to mechanical operation of the breaker. Periodic test of the quick-break latches is necessary if the breaker is to be maintained properly.

Failure of the quick-break mechanism to latch has been caused by the butt contacts of the arcing mechanism backing off and has been remedied by drilling through the cap screws which form these butt contacts and inserting pins. Backing out of the studs used as main butt contacts also has been experienced and this trouble remedied in the same manner. This is not entirely satisfactory as difficulty is experienced when it is found necessary to replace the contacts with new ones. Loss of adjustment elsewhere in the mechanism also has caused the failure of this type of mechanism to latch.

The guide rods of the quick-break mechanism are flat on one side and slide against a key which prevents them from turning. This has been subject to binding with the result that upon opening the switch the latches have disengaged immediately, throwing at least a portion of the arcing duty on the main contacts and causing a slow break in place of a rapid break. If one latch remains engaged and the other releases immediately all of the arcing duty is thrown on one break in place of the two as intended. It also has been found difficult to maintain an adjustment which will cause all latches to disengage simultaneously due to the lack of a positive stop to disengage them. They depend upon friction and spring tension to disengage them and any slight change in adjustment effects materially the time at which the latches are released.

The condition of the latching mechanisms is tested from the outside with some degree of satisfaction by means of lamps but this method does not indicate whether or not the latches are simultaneously released, as the first latch to break contact will open the circuit.

It also is necessary to remove the oil from this type of circuit breaker in order to inspect the contacts. However, a periscope is in the process of development and this, due to the fact that the contacts are not enclosed, might make it possible to inspect them without removing the oil.

Circuit Breaker Experiences of the Coast Valleys Gas & Electric Company

By T. W. SNELL

Prior to 1925 there were three 60-kv. feeder oil switches on the system. They were all of the old Pacific Electric Manufacturing Company type, 2-break, rated 60 kv., 200-amp., with current transformers mounted in the switch on one of the supporting insulators.

The switches controlled 60-kv. feeders from a bus which was supplied over two 2/0 75-mile copper lines at 60 kv. The 60-kv. supply lines were fed by a 15,000-kva. bank of 204/60-kv. transformers from a twin 104-kv. circuit.

As the 60-kv. feeders several years ago were poorly insulated the switches were subjected to frequent duty, but the reactance of supply lines and transformers was sufficient to pull the voltage down before the switches opened.

They were not equipped with bypass switches and were so mounted that a thorough inspection was impossible without raising the entire switch and causing a long interruption to service. The switches operated for five years with only such inspection as could be made through a hand hole on top of cases. During that time all of the switches operated at least 100 times under relay action and one of them operated approximately 250 times. During that period the oil was filtered once or twice and samples of oil taken showed a good dielectric test. After the switches were removed from service they were dismantled and found to be in very good condition. The contacts were burned somewhat but not sufficiently to cause poor contact; the deposit of carbon in the bottom of the tanks was slight.

Three Pacific Electric 70-kv., 250-amp., 2-break switches of late type now are in service on 60-kv., 2/0 copper lines located about 25 miles from a 10,000-kva. condenser. These have operated a few times under short-circuit conditions and have shown no evidence of distress. Three Pacific Electric 70-kv., 6-break switches recently were installed in the station where the above mentioned condenser is located, but have not opened under relay action so that there has been no indication of how they will act. All of the switches now in service are equipped with bypasses and are subjected to routine inspection.

The 60-kv. neutral is grounded at the 104/60-kv. station and also at the main switching station where the condenser and the three 6-break switches are installed.

The three original switches were removed at the time the condenser was installed so they did not operate under that additional burden.

The operating experience of this company demonstrates that very small switching capacity can be used when there is sufficient line reactance to reduce the interrupting duty.

Oil Circuit Breaker Report of the San Joaquin Light & Power Corporation

By R. C. DENNY

The subject of oil circuit breakers as presented by this company last year dealt largely with methods of increasing the rupturing capacity of existing breakers that otherwise would have become obsolete owing to the increased capacity of the system. It may be noticed from the tabulation of circuit breakers that the old 70-kv., 2-break, 200-amp. Kelman breaker is greatly in the majority on the San Joaquin system. Most of these old breakers are getting by in service because of their particular locations on the system; usually remote enough, by reason of the high reactance of the connecting transmission lines, to limit the short-circuit currents to within safe rupturing values. At several points, however, rather than discard these 2-break switches where stations were being remodeled they were connected up two in series to operate simultaneously thus being in effect one 4-break switch.

In the past three years the new transmission breakers that are being installed in largest numbers are the Keyman type CB72, 4-break as shown in Fig. 1. Practically all of the 110-kv. Kelman breakers in use are of this same type except for larger tanks and bushings. A few of the Kelman type D4 breakers are in service. These are the same as the type D-6 except for the number of breaks. These breakers may be increased to 10 breaks by adding pantograph units. There have been no special tests made on the transmission system to determine the ultimate rupturing capacity of any type of breaker nor does there seem to be much opportunity to conduct such tests in an experimental way. However, the breakers are undergoing tests in actual service that give some valuable data even though not approaching the accuracy of experimental set-ups.

Pursuant to the action of the apparatus committee of 1924-5 in adopting a definite plan of recording

breaker operations this company has, during the past 11 months endeavored to analyze each transmission-breaker operation with the yiew of ascertaining at least the approximate current ruptured in each case and to note the resulting condition of the breakers. The calculating board built by the company and described in 1925 committee papers was of considerable assistance in this study. However, the fact is fully realized that it is most impossible to simulate the trouble conditions exactly even though their nature

TABLE I.—Transmission oil circuit breakers of the San Joaquin Light & Power Corporation

	In Power Houses		In Substations		
Voltage	Transformer Breakers	Line Breakers	Transformer Breakers	Line Breakers	Total
33-kv.	2	2	7	5	16
69-kv.	17	14	53	72	156
110-kv.	5	4	8	11	28
Totals	24	20	68	88	200

Manufacturer	33-kv.	69-kv.	110-kv.	Total
Kelman Elec. & Mfg.	16	140	24	180
Pac. Elec. Mfg. Co.	..	7	..	7
Gen'l Elec. Co.	..	9	..	9
Westinghouse Elec.	..	..	4	4
Totals	16	156	28	200

Further Classification of Above Breakers

Make	Style	Voltage (kv.)	Breaks	Amps.	Type
Old Kelman	Indoor	70	2	200	C-1
Old Kelman	Outdoor	70	2	200	CB-7
New Kelman	Outdoor	70	4	400	CB-72
Old P. E. M.	Outdoor	70	2	300	866
G. E. Co.	Indoor	70	2	150	F Form K-10
G. E. Co.	Outdoor	70	2	150	F Form KO-26
New Kelman	Outdoor	110	4	400	CB-72
New Kelman	Outdoor	110	4	400	D-4
Westinghouse	Outdoor	110	2	400	G-11

might be known. Due to the unusual amount of lightning and severity of the storms during the past season there has been an unusual number of trip-outs of the transmission breakers. In fact during the past 10½ months' operation there have been 394 trip-outs, the great majority being on the 69-kv. system. In spite of this seemingly great number of trip-outs the power service has not suffered particularly owing to the layout of the transmission system which provides two or more feeders for each substation.

Ordinarily, on loop systems, two trip-outs per case of line trouble would be expected. Some troubles may cause more than two trip-outs and some less, therefore, upon analyzing the 394 trip-outs it is rather surprising to find that the ratio of trip-outs to troubles is only 1.23/1. Of course some troubles occur on stub lines where it is necessary for only one breaker to trip. In other cases the tripping of one breaker so reduces the voltage that the arc clears before another breaker can trip. This of course shows on the face of the thing that there cannot be many trip-outs when there should not be. Another interesting finding is that out of the 230 disturbances causing trip-outs there were only 90 cases or 39 per cent where the line actually was disabled so that it could not be closed right back into service. It might very well be said then, that the difference or 61 per cent of potential line failures were prevented by the automatic operation of breakers.

Getting back to the actual operations with respect to rupturing duty it might be well to review the short-circuit characteristics of the transmission system on which these switches operate. Based on full load operation of 203,300 kva., all plants on the line and including interconnections, the normal full-load current would be 1,690 amp. on a 69-kv. basis, or 1,070 amp. on a 110-kv. basis. Tests on the calculating board seem to indicate the average system reactance to be in the neighborhood of 63 per cent. The total instantaneous 3-phase short-circuit current on the 69-kv. system thus is limited to approximately 2,700 amp. and on the 110-kv. system to 1,700 amp. Instantaneous values for phase-to-phase shorts may be 1½ times these values and for grounds 2½ times. However, owing to the time delay imposed by the protective relays and the mechanical action of the breakers themselves which total is on the order of ¼ sec. at the very minimum, it is found that the current falls to considerably lower values. Thus in the great majority of cases the breakers successfully rupture the currents.

Over the period covered by this report there have been six occurrences which, although classed as circuit-breaker failures, were not all failures to rupture but rather tank or bushing failures due to secondary or gas explosions. However, if these had been failures to rupture, the percentage of failures out of 394 trip-outs would have been just about 1.5 per cent or 3 per cent of the number of breakers in service. The total short-circuit current is not often broken by any one breaker in a loop system, but rather by breakers on stub lines. When such lines are out of substations

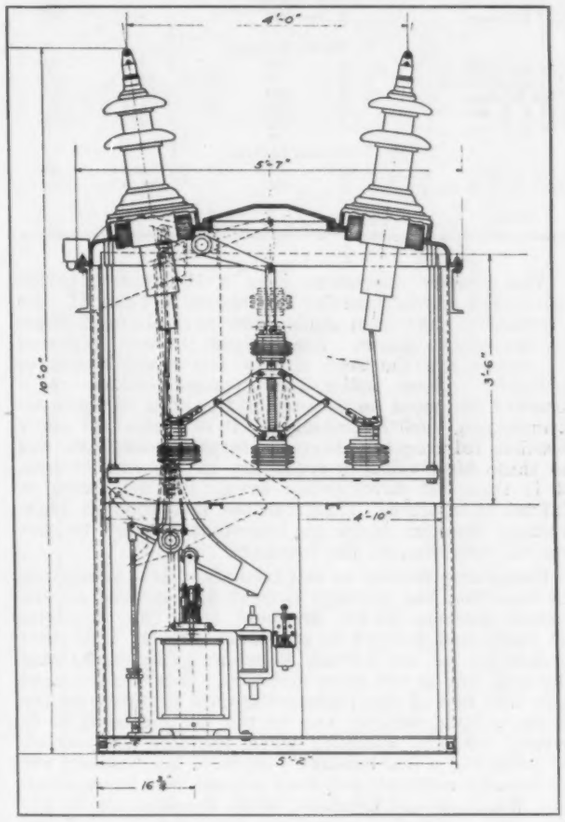


Fig. 1. Kelman 70-kv., 4-break oil circuit breaker; sectional view, typical construction.

which are in a loop or have several sources of power the rupturing duty may be extremely severe. This is true of the high-voltage breaker on a substation transformer bank although admittedly there is not nearly as great a chance for trouble there as on a line of appreciable length. The breaker failures mentioned were far from being wrecks as usually only one tank was affected and soon was repaired and put back into service. Surprising to say the contacts have been found in fairly good condition after apparently serious failures. This probably is a good indication that the failure was due to a secondary explosion. Some failures have been due to flashovers inside the tanks due to birds' nests. Hence it has been found necessary to plug up all holes or cracks about the breaker covers.

This company has no definite program of internal breaker inspection based on number of operations. It has been the practice of going into breakers only after they exhibit signs of stress after troubles, or in case any appreciable quantity of oil is thrown out. The fact that breakers emit smoke during operations does not necessarily justify opening up a breaker for inspection. The analysis and record of breaker operations now being kept is expected to bring out a somewhat definite relation between the number and severity of operations and the necessity for inspection. At any rate at the present when a breaker is opened

for inspection and maintenance its record of operations is studied to establish, if possible, any significant facts as related to the findings. Practically all the transmission breakers that operate automatically are equipped with bypass switches so that it is possible to take the breaker out of service without interruption to service.

TABLE II.—Summary of oil circuit breaker tripouts on San Joaquin Lt. & Pr. Corp. System over 10½-month period—April 15 to March 1, 1926

Make	Breaks	Amps.	No. Tripouts	Av. Cur. Ruptured (amps.)	Max. Cur. Ruptured (amps.)
33-kv. System					
Old Kelmans	2	200	22	510	890
69-kv. System					
Old Kelmans	2	200	192	776	2700
Rebuilt Kelmans	4	200	29	1335	3050
New Kelmans	4	400	75	1019	2400
Old P. E. M.	2	300	36	470	1575
Old G. E.	2	400	7	993	2590
110-kv. System					
New Kelmans	4	400	31	898	1780
New W. E. & M.	2	400	2	1045	1505
Total			394		

The breaker operations over a 10½-month period have been summarized for this report in Table II. No distinction has been made between 3-phase, 2-phase or star-phase shorts. The highest currents ruptured of course are the ones due to star-phase shorts or grounds. These inflict the greatest strains on a breaker but more on account of the high voltages accompanying such disturbances. It is likely that many breaker failures are due to internal break-down due to these high voltages secondary to the real trouble, it is true, but nevertheless wrongfully attributed to failure to rupture. Therefore the insulation of high-voltage breakers bears an important relation to successful operation of the breakers.

Remarking further on the tabulation it is interesting to note that the average current as ruptured by the rebuilt Kelman 69-kv. breakers (the two in series as mentioned before) is somewhat greater than that broken by the old 2-break Kelmans. This shows that the step was in the right direction. It may be noticed also that one of the highest currents ruptured on the 69-kv. system was by one of the old indoor G.E. 2-break, 150-amp. breakers when the line was struck by lightning a few hundred feet from the breaker, yet no damage resulted; not even any oil was thrown out. The Westinghouse breakers, while considerably in the minority, got in two operations as may be noticed and ruptured slightly more current on the average than their 4-break competitors, yet fully as successfully. The conclusions are that circuit breakers fail for reasons other than purely the inability to rupture current and that tank strength and insulation are quite as important as the number of breaks, speed of operation, or other features of design.

Circuit Breaker Experiences of the Los Angeles Bureau of Power and Light

By H. H. COX

Circuit breakers in service at distribution stations of the Los Angeles Bureau of Power & Light

No.	Make	Type	Amps.	Breaks	Style
	33-kv. Breakers				
7	Kelman	CB2	250	2	Indoor
50	Kelman	CB3	250	2	Indoor
1	Kelman	CB4	250	2	Outdoor
5	Kelman	CB7	250	2	Outdoor
7	Kelman	CB24	300	4	Indoor
62	Kelman	CB36	300	6	Indoor
2	Kelman	CB76	300	6	Outdoor
33	Kelman	2D6	300 600 1,200	6	Indoor
2	Kelman	2D10	600	10	Indoor
36	Kelman	DA6	300	6	Outdoor
	110-kv. Breakers				
24	Westinghouse	GA	600		Reactance type
2	Westinghouse	G11	800		
10	G. E.	FK36	600		

110-kv. Switches

During the year there have been several relay operations on these breakers and although they throw a little oil and smoke they have in all cases satisfactorily opened the shorts. It is believed that they are approaching the limit of their interrupting capacity. The duty on these switches at the Los Angeles end of the system is about 800,000 kva. There is some evidence of vertical movement of these switches when interrupting short circuits, due to oil throw.

The reactance-type breakers have given much mechanical trouble due to the complexity of the mechanism. All rigid oil-pipe connections have been removed from these switches on account of the motion due to oil throw and as an earthquake protection.

33-kv. Switches

The principal feature of the year has been the installation of 36 of a new type of switch which was designed to stand up under heavy internal pressure. This is the Kelman DA-6. It is a 6-break switch with all parts designed to stand up to about 900 lb. per sq.in. It is provided with a blowout plate which is intended to go considerably under the 900-lb. limit.

The design of this switch was brought about by a study of what happened to breakers when they really failed. In almost every case under this study there was a tank failure due to weakness of tank design. Following out this same line of thought a complete survey of all breakers in use was made and a program now is under way to bring all switches up to certain standards of tank strength. Through the co-operation of the local manufacturer this has been made possible. Cast-steel heads have been replaced by cast iron. Thicker boiler-plate tanks with oval ends and reinforced sides and bottoms have replaced sheet-metal tanks; 4-break switches have been changed to 6; and all this at moderate cost with no unnecessary delay. In most cases it is possible to make a breaker that will stand 150-lb. internal pressure while a smaller number will be brought up to 50 or 60 lb.

Several short circuits of from 500,000 to 750,000 kva. have been opened successfully during the year.

Maintenance Methods

Considerable study has been done on switch maintenance during the year. The principal feature noted on the heavier short circuits is the increased amount of carbon formed and the very evident magnetic blowout action on currents of 8,000 amp. and above. Our study and observations have caused us to increase our vigilance in switch maintenance, with more frequent overhauls. The number of short circuits allowed before inspection has been cut down from about six to only two or three.

Oil Circuit Breakers in Use by the Southern California Edison Company

The following table will furnish a list of the high-tension oil circuit breakers in use on the system of the Southern California Edison Company, classified according to voltage and manufacture:

Manufacture	Automatic	Non-Automatic
60 kv.		
General Electric Co.	63	12
West'house Elec. & Mfg. Co.	36	0
Kelman Elec. Co.	385	26
150 kv.		
General Electric Co.	19	14
Westinghouse Co.	7	6
220 kv.		
General Electric Co.	14	0
Westinghouse Co.	16	4

Kelman Switches

From a study of the above table it may be seen that the majority of the switches in use on the system of the Southern California Edison Company are of Kelman Electric Company manufacture. These switches have been in service on the system for a number of years and when proper consideration has been given to the application, they have given good service. In common with other types of switches, it has been necessary to see that the growth of the system does not impose greater short-circuit stresses upon the switch than originally was intended.

OIL SWITCH OPERATING RECORD
PROTECTION ENGINEERING DEPARTMENT
SOUTHERN CALIFORNIA EDISON COMPANY.

Date _____
Time A.M. _____
Time P.M. _____

Switch Location _____ Name or Number of Switch _____

Manufacturer's Name _____ Type of Switch (Automatic _____ Non-Automatic _____)
Manufacturer's Number _____ Type of Oil Used _____ (No. of Breaks _____)

Voltage _____ Rated Current Capacity (Carrying _____ Rupturing _____)

Number of Automatic Openings since last overhaul _____

Nature of Overload Ground _____ Single Phase _____ Three Phase _____ Approx. Current Interrupted _____

Findings:	Phase A	Phase B	Phase C
General External Conditions: Bushings broken or cracked			
General External Conditions: Switch top broken or cracked			
General External Conditions: Tanks bulged or split			
General External Conditions: Oil spillage or leakage			
Internal Conditions: Bushings			
Internal Conditions: Blades			
Internal Conditions: Contacts			
Internal Conditions: Oil (dirty, wet or carbonized)			

Was Opening Satisfactory? _____

E. R. Stauffacher
Protection Engineer.

By .....

Fig. 1. Oil circuit breaker operation record used by the protection engineering department of the Southern California Edison Company.

The greater portion of these switches are solenoid operated although a number are operated by compressed air with electric trip. It has been found that close attention must be given to the operating mechanism so that any defects which might develop in operation and which would interfere with the satisfactory functioning of the switch, are located before the switch is called upon to clear a severe short circuit. The present tendency of the manufacturer of this switch is to go to heavier tanks than heretofore used and to decrease the size of tanks insofar as proper clearance to ground will permit. There have been a number of installations in southern California using the extreme heavy duty Kelman switch, but to date there has not been sufficient experience to see what improvement the heavier tank with a smaller amount of oil provides as against the larger tank with the larger amount of oil. Improvements recently have been made in the design of the arcing tips so that there will be less tendency for the switch contacts to weld when the switch is closing in on a short circuit.

General Electric Switches

There have been a few installations of extreme heavy-duty switches manufactured by the General Electric Company for use on 70-kv. or, as it is commonly known, 60-kv. operating systems. At the Long Beach steam plant of the Southern California Edison Company 60-kv. breakers have been installed having an interrupting capacity of 1,250,000 kva. At the Eagle Rock substation 60-kv. breakers have been installed of a similar design having an interrupting capacity of one million kva. There is no doubt but that the growth of the system soon will result in a test of those switches, at the time of a short circuit, up to the limit of their interrupting-capacity rating.

The 150-kv. and the 220-kv. oil circuit breakers of modern design have been called upon a number of times to operate and have given satisfactory performance. There is a case of one of the older designs of 150-kv. oil circuit breakers in use on the Big Creek system causing some trouble, apparently due to loosening of contacts or to a flashover of the bushing inside of the breaker. These extra-high-voltage breakers have not been called upon to interrupt short-circuit current up to their full rated kva. However, within the next few years these breakers will be subjected to short-circuit duties between a million and 1½ million kva., which will be near the limit of their capacity.

Westinghouse Switches

The 60-kv. and the 220-kv. switches of this manufacture which are in use on the system are mostly of modern design and very little trouble has been experienced in their normal operation and in their per-

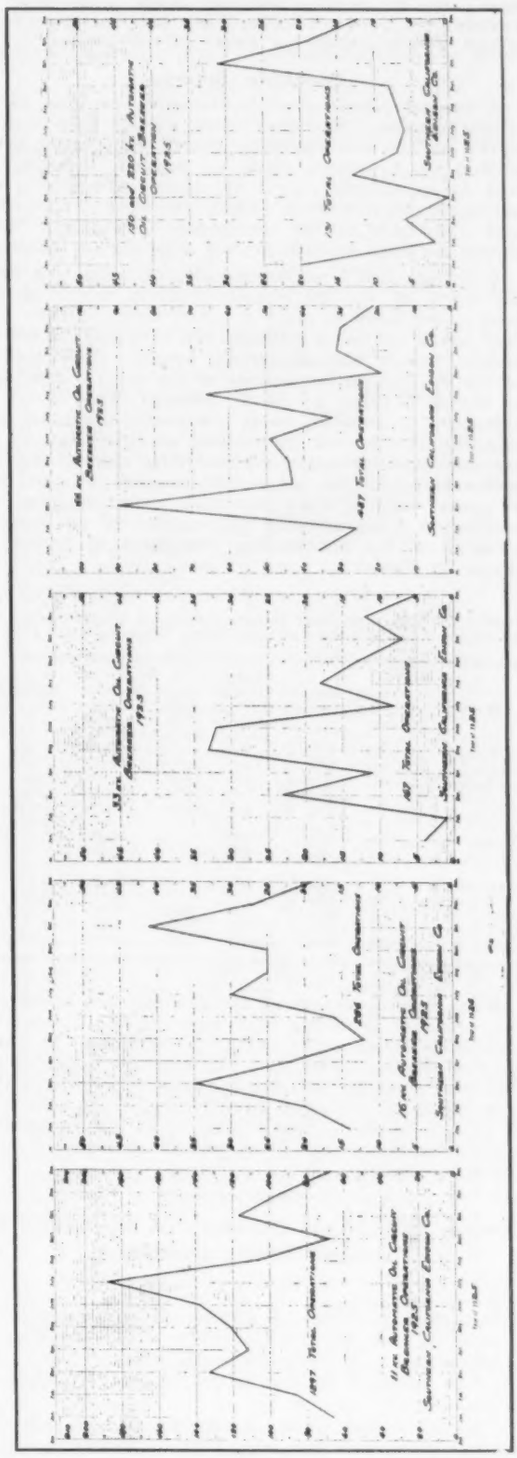


Fig. 2. Series of record sheets showing graphically the number of operations of each class of oil circuit breakers on the system of the Southern California Edison Company for 1925.

formance at the time of clearing short circuits. There has been some trouble on the higher voltage breakers due to loosening of some of the internal mechanism of the switch as a result either of sustained vibration or severe normal operating service. The 150-kv. breakers, while of an older design, have given good service and no outstanding trouble has developed with them.

All of the higher voltage switches on the system are manually controlled and no reclosing mechanism to be adapted to these switches is contemplated in the near future. The reclosing mechanism is being used and is being considered more and more on switches of lower voltage, but that feature of oil circuit breakers does not apply in this report.

Operating Records

A careful record of the automatic operation of oil circuit breakers has been kept during 1925 and is shown on the accompanying charts, each chart being plotted in a certain class as regards voltage. It may be noted that charts are presented showing the automatic operation of 11-kv., 16-kv., 33-kv., 66-kv., and 150 and 220-kv. automatic switches. These charts are submitted in lieu of a tabulated summary.

A system has been inaugurated of making a careful check of the oil circuit breakers where it has been called upon to clear a heavy short circuit. The data which are being collected are based on the recommendations of the oil circuit breaker subcommittee of the P.C.E.A. and a sample of the record form used is shown in Fig. 1. It is believed that it is unnecessary to consider every automatic operation and calculate the current interrupted at this time, as we are interested primarily in observing and setting the performance of the oil circuit breaker at the time of heavy duty or duty somewhat near its rated capacity. A table showing the results of an analysis of some of the outstanding clearances of trouble is shown in Table I.

TABLE I.—Some examples of automatic oil circuit breaker operation on the system of the Southern California Edison Company during 1925.

Station	Voltage of Circ. (kv)	Make of Breaker	Normal Current carrying capacity (amps.)	Rated Rup. Cap. (amps.)	Current Interrupted (amps.)	Result of Auto. Oper.
Belmont.....	11	Mfg. B	300	1735	2630	Blew up
Katella.....	11	Mfg. A	1200	11550	8800	Spilled oil
San Bernardino	11	Mfg. B	300	1735	925	Smoked
Venice Hill....	11	Mgf. B	300	1735	1095	Smoked badly
Vernon.....	15	Mfg. A	600	12320	13400	Threw oil Smoked
Carson.....	15	Mfg. C	800	..	7050	Threw oil
Chino.....	60	Mfg. C	400	..	1980	Threw oil Smoked
Laguna Bell...	60	Mfg. C	400	..	6800	O. K.
San Fernando..	60	Mfg. C	300	..	4680	Blew up
Eagle Rock...	150	Mfg. B	300	3610	860	O. K.
B. C. No. 3...	220	Mfg. A	600	2620	486	O. K.
Laguna Bell...	220	Mfg. B	600	3940	660	O. K.

More careful records of the performance of oil circuit breakers are being kept each day, both from the standpoint of automatic operation and from the standpoint of routine operation. The experience during the past year certainly justifies this practice and shows that care taken in operation and frequent overhauling of oil circuit breakers goes a long ways toward keeping down troubles on this very important piece of electrical apparatus.

System Oil Circuit Breakers of the California Oregon Power Company

By R. S. DANIELS

This company has in service on its transmission system 19 Kelman 70-kv. breakers, 7 Pacific Electric Manufacturing Company 66-kv., 5 Westinghouse 73-kv. and one same of 132-kv. rating; a total of 32 high-voltage breakers.

Enough breakers have not been in service a sufficient time to give much information from experience. It is believed that the principal inadequacy shown has been lack of mechanical strength and lack of size. It is believed that nearly all troubles, which on the whole have been comparatively few, have been due to the breaker being too small for its job. It can be said therefore that the greater part of our maintenance has been due to lack of mechanical strength.

A very complete record of the performance of breakers has not been kept and no regular periods of inspections have been made. Maintenance and overhauling has been done only after signs of trouble, or when breakers were moved to new locations. It has not yet been our practice to make inspections after any certain number of operations, although it is believed that this should be done.

Circuit Breaker Experiences of Los Angeles Gas & Electric Corporation

By F. R. KNIGHT

This company's experience with oil circuit breakers has been very satisfactory. This has made it hard to furnish a report worth while. Our experience may be due partly to selecting breakers of a capacity ample to rupture maximum shorts at the point of installation. We use oil only as specified by manufacturer. A shipment of oil is checked for fire, flash, viscosity, acidity and dielectric strength, to see that it meets their specifications.

Large breakers are inspected once in six months of normal operation. After clearing a short they are opened at once, cleaned, the oil is filtered and inspected, and adjusted if necessary. The only breakers at and between power houses are General Electric and Westinghouse.

We have had a little trouble with some breakers hanging up on the quick-break mechanism of the arcing contacts. This was caused by the use of a too-heavy spring in this mechanism. However, this caused no serious difficulty as the switches were not clearing a short at the time.

A list of the more important breakers at our two power plants is given in Table I.

TABLE I.—Circuit breakers in service on the system of the Los Angeles Gas & Electric Corporation

No. in use	Mfr.	Type	Capacity	Possible Short
		At Seal Beach Station		
4	West.	G-22	110-kv., 400-amp.	3,950 amp.
2	West.	G-22	110-kv., 600-amp.	3,950 amp.
		At Alameda Street Station		
4	G. E.	FH-206	15-kv., 1,200-amp.	11,800 amp.
16	G. E.	FH-203	15-kv., 500-amp.	15,000 amp.
4	G. E.	FH-206	35-kv., 500-amp.	11,800 amp. at 15 kv.
8	G. E.	FH-203	35-kv., 500-amp.	15,000 amp. at 15 kv.
1	G. E.	FH-209	15-kv., 5,000-amp.	38,600 amp. at 2.4 kv.

NOTE. The 35-kv. switches are operating on 15-kv. lines. The FH-209 is operating on 2.4 kv.

Oil Circuit Breakers on System of The Southern Sierras Power Company

The Southern Sierras Power Company, oil circuit breakers in service

No.	Mfr.	Type	KV	Amps.	Breaks	Remarks
3	W. E. M. Co.....	G-2	115	400	2	
2	Kelman.....	..	110	200	2	
4	W. E. M. Co.....	G-2	95	400	2	
3	Kelman.....	..	88	200	2	
1	Kelman.....	..	70	200	4	
2	Kelman.....	..	60	200	4	
6	Kelman.....	..	60	200	2	
12	Kelman.....	..	60	200	2	Non-automatic
1	Kelman.....	..	55	200	2	
2	Kelman.....	..	35	200	4	
34	Kelman.....	..	35	200	2	
4	Kelman.....	..	15	200	2	
3	W. E. M. Co.....	..	15	200	2	

Electrical Grounds*

By F. H. MAYER

The subject of grounds is attracting more attention today than ever before in the history of the electrical industry. This may be accounted for in numerous ways.

At the beginning of the electrical industry generating units were small and, as a result of the fact that insulation was poor, it was considered more important to insulate the frame of the generators and motors than to make a special effort to ground them.

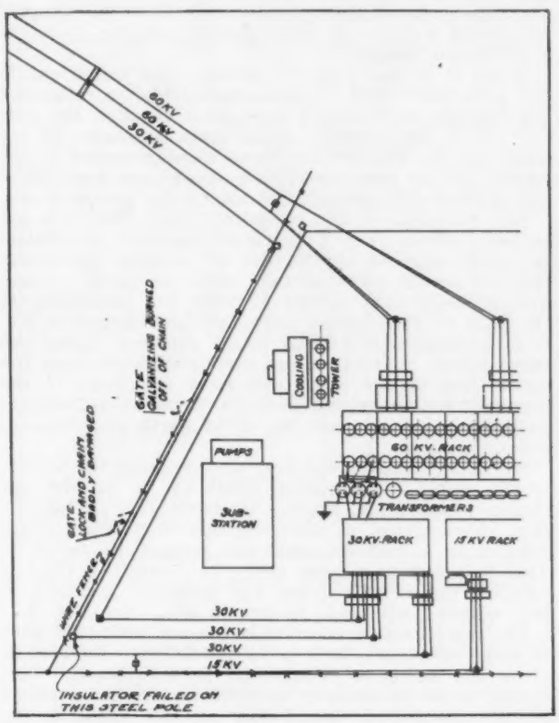


Fig. 1. Plot plan of L. A. No. 3 substation of Southern California Edison Company showing relation of pole where insulator failed to rest of equipment.

Later, as the manufacture of insulating material was better understood, the practice of insulating the frame of the equipment became less common. The fact that lighting constituted the major portion of the load and that distribution lines extended over quite an area, no branch of which carried very much current, the voltage was low. Thus when a ground occurred the reactance of the line, considering the low voltage used for distribution, limited the current to such an extent that the matter of potential gradient and ground current control was of no concern.

When generating capacities became larger and higher voltages were used it became more and more recognized that the grounding of all equipment was important. However, due to the evolution of the practice of insulating the frames of the generators and motors, contrary to that of grounding of the same, there seems to have been considerable lag in the methods over the demand of the real requirements.

With the present policy of most public utilities of massing large blocks of power by means of interconnection this apparent lag is being appreciated more than ever before. There has been sufficient interest stimulated to cause a national study to be made of the subject by the a.c. substation subcommittee of the electrical apparatus committee of the N.E.L.A., the report of which is dated April, 1925.

In general the industry is pretty well agreed upon the chief functions of an a.c. grounding system, namely, protection to life and continuity of service. However, there seems to be some question as to the exact method of accomplishing these ends.

The fundamental points in any grounding system are as given below. While the discussion applies more directly to the grounding of substations and powerhouses, the principle in other types of grounding is involved.

1. That current on the occurrence of an accidental ground always passes or tends to pass from the point of failure to the generator neutral or transformer neutral, or in case of an isolated system to some point of defective insulation on other phases.

2. That when current passes over a conductor there is a potential drop due to the loss in the conductor, ordinarily referred to as the potential gradient. Due to the heavy capacities back of most systems this is a factor that enters in on nearly all station grounding.

3. That current will follow the path of least resistance.

For failure that is foreign to the station, the first consideration can be cared for by the use of ground electrodes. For the best protection these ground electrodes should be tied to every medium of return. For example, if a pipe line or a wire fence parallels

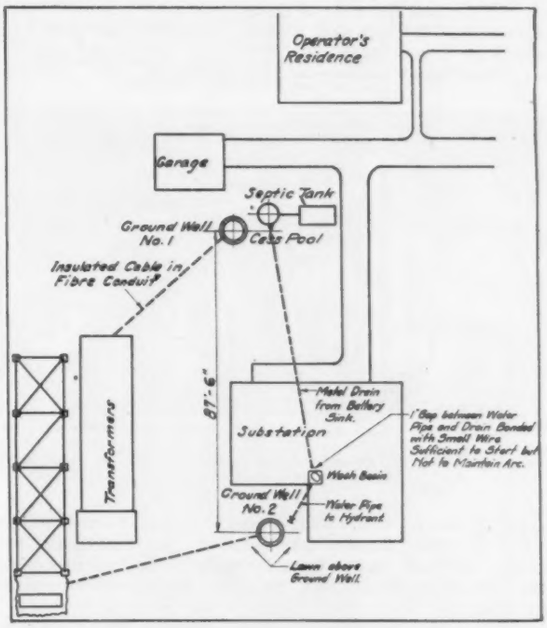


Fig. 2. Plot plan of substation grounds where stray ground current damaged water pipe and other equipment in seeking return path to ground well.

or crosses somewhere near a line failure to ground the pipe or fence in many cases will serve as a better conductor to the transformer neutral than will the earth. Unless there is at the station a low-resistance path from this medium of return to the transformer neutral there may be a sufficient difference of potential developed to force the current through some of the vital parts of the station. It even may prove hazardous to the operators.

Operating Experiences

The experience of the Southern California Edison Company at its Los Angeles No. 3 substation stressed the importance of the above points. Near this station there occurred on one of the steel poles a failure of one of the 30-kv. insulators which caused the pole to be energized, Fig. 1. The pole was set in concrete and not grounded. Evidences showed of the current's passage over the surface of the ground a distance of approximately 2 ft. to the property fence, following the fence and passing through a chain and lock on two gates and thence over to the substation structure.

* Report of Joint Subcommittee of Electrical Apparatus Committee, Overhead Systems Committee, and Safety Rules Committee. F. H. Mayer, Southern California Edison Company, chairman. F. E. Dellinger, Los Angeles Gas & Electric Corporation. E. R. Stauffacher, Southern California Edison Company. W. H. Talbott, San Diego Consolidated Gas & Electric Company. G. E. Nott, Southern California Telephone Company. H. N. Kalb, San Joaquin Light & Power Corporation. G. E. Young, Pacific Gas and Electric Company. R. H. Cates, Southern California Edison Company.

The first lock and chain were damaged beyond use and the second had the galvanizing completely burned off. All along the fence there was evidence of the passage of current from the fence to the posts; the metal on the fence posts was blistered. This, however, was less noticeable nearer the substation.

This incident stresses the importance of tying all steel poles on the property, and each section of fence immediately around the property, to the station grounding system. It happened that this pole had no grounds of any kind, but it is believed by the engineers that, even though the pole were grounded to a driven pipe, due to the limited amount of moisture in the soil the current would have taken the same course as it did without the ground.

For failures at the station it is necessary to have all steel, transformer cases and oil circuit breaker tanks grounded to the transformer neutral. Should this not be done and the neutral ground isolated from the steel ground at the time of trouble, due to the reactance between the two grounds there is danger of high-potential stresses developing between the

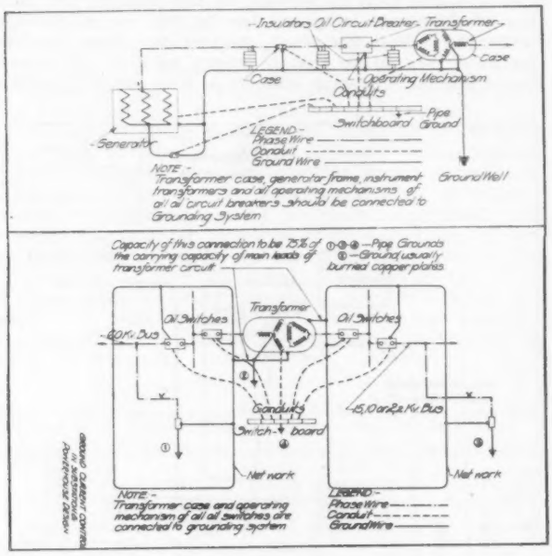


Fig. 3. Plans of ground-wire systems that provide adequately for return of ground current.

neutral end of the winding and the transformer cases. This is true particularly should the lightning arrester ground be of considerably less reactance to the steel ground than to the transformer-neutral ground.

One of the members of this subcommittee took exception to the grounding of all non-current-carrying structures to the neutral of the transformers; therefore the following:

It has been the practice for the past three years for the Southern California Edison Company to tie all non-current-carrying structures to the neutral of the transformers together and there has been no difficulty experienced in so doing. However, prior to that time transformer neutrals and equipment were isolated and grounded to separate ground wells. The difficulties experienced at one of these substations as a result of this practice are given in the following paragraphs.

The trouble showed up, following a flashover on the 60-kv. rack, in the water piping in the wash room of the substation where a metal sewer pipe crossed near the water pipe.

Figure 2 shows in a general way the two ground wells of the substaiton, also the location of these wells. Ground well No. 1 is for the neutral of the transformer. Ground well No. 2 is for the so-called station ground. The neutral conductor of the 60-kv. side of the power transformers is carried on insulators and run into the ground well through fiber conduit. In other words it is isolated from all equipment including the earth along the path to this particular ground well. The station ground consists of a limited network which ties to the structural part of the rack and also to the transformer cases. This network is tied to ground well No. 2.

A flashover occurred on the 60-kv. rack, a discharge from one leg of the 60-kv. line to the steel at the point of support. The lowest-resistance path for the current thus dicharged was to the neutral of the transformer. Analyzing it from this point of view it would seem most probable that the current which went astray was conducted to ground well No. 2 and from No. 2 to the water pipe which terminated near ground well No. 2. The current then jumped a small gap between the water pipe and drain, through the drain to cesspool, through the earth from the cesspool to ground well No. 1, from ground well No. 1 to the transformer neutral.

While it is true that the damage was small, should the path have been of considerably higher resistance the current might easily have gone through the control board and proved much more serious. If the steel and the transformer cases were grounded to the neutral at the rack the circuit would have been satisfied without the necessity of taking the course it did.

The majority of the committee feels that this experience shows that it is more important to control the stray current by the use of metallic conductors than to secure mere contact with the earth. These ground wells gave a test of very low resistance at the time of installation, but notwithstanding this fact it is proved by the path which evidence shows the current took that there was less resistance from the water pipe to the drain and from the drain to the cesspool, and to ground well No. 2 than the alternate path from ground well No. 2 to earth and then to ground well No. 1.

By taking care of the first consideration the matter of the second consideration, which has to do with potential gradient, is practically cared for. When all steel is grounded, at all piers and foundations there usually is a sufficient network formed to serve as what is known as a large plate; as a result of the low conductivity of this plate the potential gradient is held within limits safe to human life. See Fig. 3.

The third consideration, that current seeks the path of least resistance, is a point particularly interesting when the safety of equipment is considered. This applies more particularly to remote-controlled stations where the control board has conduit radiating to various equipment. Should a failure occur on any part of the station equipment the stray current thus formed would pass to the neutral of the transformer.

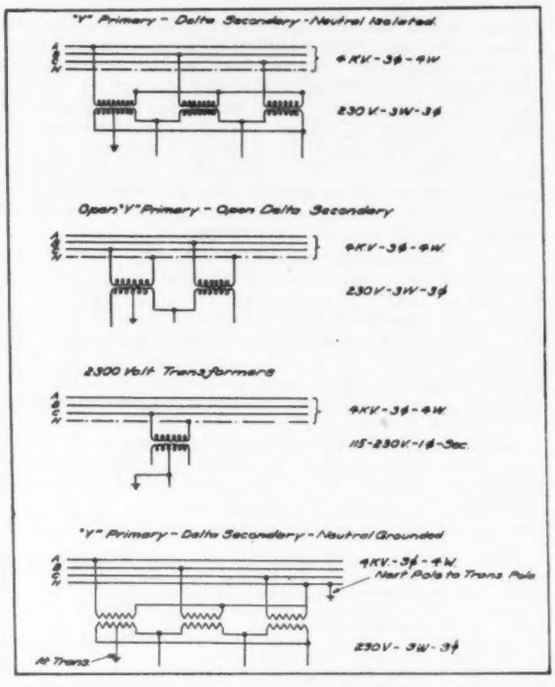

"Y" Primary - Delta Secondary - Neutral Isolated
4 KV - 3φ - 4W
230 V - 3W - 3φ
Open "Y" Primary - Open Delta Secondary
4 KV - 3φ - 4W
230 V - 3W - 3φ
2300 Volt Transformers
4 KV - 3φ - 4W
115-230 V - 1φ - Sec.
"Y" Primary - Delta Secondary - Neutral Grounded
4 KV - 3φ - 4W
Neut Pole to Trans Pole
230 V - 3W - 3φ
At Trans.

Fig. 4. Different ground connections used by various companies.

The conduit which radiates from one part of the equipment to the other may be in direct line or of lower resistance than the path through the earth's surface. Thus it is important to by-pass the control board with a conductor of impedance low enough to prevent any stray ground current from passing through the control board.

Building structures, immediately along the area where conductors of heavy carrying capacity are run, likewise should be supplemented by heavy ground cable. Thus at the time of a failure of any insulating support the cable will serve to keep the current out of the reinforcing of the building and also relieve the danger of current destroying the plumbing and other

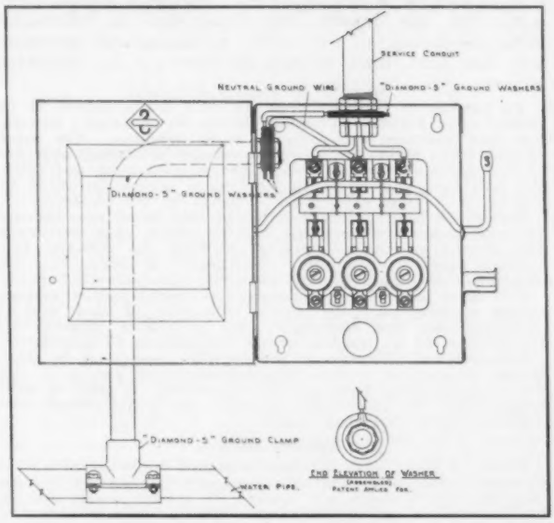


Fig. 5. Approved method of grounding at service switch.

fixtures; see Fig. 3 (upper).

At the beginning of the year the committee decided to study the following subjects:

1. Grounding of distribution lines, more particularly as applied to 4-kv., 3-phase, 4-wire systems, with the object of safety, continuity of service, and a minimum amount of communication disturbances.
2. Grounding on consumer's premises.
3. Grounding of substations and powerhouses.

Grounding of Distribution Lines as Affecting the Power Company

As mentioned above, the committee undertook a study of the grounding of distribution lines, more particularly as applied to 4-kv., 3-phase, 4-wire systems from the standpoint of safety, continuity of service, and a minimum amount of communication disturbance. Time did not permit an extensive study, but certain fundamentals in connection with the problem were discussed in considerable detail. Specific methods for obtaining grounds were not discussed.

The study resolved into a comparision of certain fundamental features of the 3-phase, 4-wire systems that operate with only one ground on the neutral, this ground being located at the substation; and those systems in which the neutral wire is grounded at several points. Examples of both of these systems are in successful operation on the Pacific Coast.

Fig. 4 shows a series of different connections used by various companies. Most companies feel that the distributed ground on the neutral wire has advantages over that of grounding the neutral at the station only. However both systems are used. It may be noted in the diagrams that some companies ground the neutral of 3-phase transformer banks while others isolate them. The fact that there has been some difficulty in the southern part of the state to get sufficient current to flow at the time of a failure of any one phase of a 4-kv., 3-phase, 4-wire system to trip out the circuit breakers, caused the following tests to be made. The committee is submitting results of the tests because of their interest, the conclusions of which will be left to the individual reader:

Grounding Tests on 4-kv., 3-phase, 4-wire

Date—September 10, 1925.

Circuit—4-kv. distribution with neutral of transformer bank and neutral wire grounded only at the station.

Problem—To determine the amount of current which would flow on a 4-kv. grounded-neutral circuit. A series of tests was made. A point approximately one mile from the station on the edge of a recently irrigated walnut grove was the location selected for these tests.

Results

Time—11:39 a.m. Coil of bare No. 6 B.&S. copper wire dropped on ground after one end of coil had been attached to one of the phase wires. Slight arc resulted, 0.3 to 0.6 amp. measured current.

Time—11:56 a.m. Duplicate of above. Results practically the same. Sizzling arc, 0.3 to 0.5-amp. measured current.

Time—11:58 a.m. Coil of wire moved over to green grass. Slightly greater arc. 1 to 3.0-amp. measured current.

Time—12:00 noon. Coil of wire moved over to edge of a pool of water. Much more pronounced arc, 3 to 6-amp. measured current.

Time—12:02 p.m. Coil of wire pulled into the pool of water. Vicious arc, 25 to 30-amp. measured current.

Then the same tests were made with insulated wire in fairly good condition. Results were practically the same when the bare end of the wire came into contact with the soil, grass or water. Later the insulation broke through, when the wire was lying in water.

The feeder switch was set at a minimum trip of 115 amp. During all the tests the breaker did not trip out until the ground wire was fastened to a pole anchor and to a bare place on the insulated wire brought into contact with the anchor.

Later operating experience has shown that during storm conditions and with a wire down a feeder switch will trip out, but it appears advisable to

Fig. 6. Result of breakdown on consumer's premises, ahead of all fuses. Service not properly grounded outside of building.

ground the neutral at as many places as practicable along the line as well as in the station.

Grounding Distribution as Affecting Communication

In order that a more complete understanding might be obtained regarding the effects upon communication lines of the grounding of distribution lines a representative of the Southern California Telephone Company was requested to present a discussion of the inductive effects of 3-phase, 4-wire distribution systems upon telephone circuits. This request was made since it was understood that various systems differed materially in regard to their inductive influence. It also was believed that, when considered broadly, the study should embrace those feature which

affect consumers who are in general common to both power and telephone companies.

Summarized briefly, the discussion received indicated that the system operating with the single ground was preferable from the standpoint of the communication utilities. It was stated that such a system was, in general, comparable as regards inductive influence to a 3-phase, 3-wire system transmitting equal power, and such systems had been generally operated in close proximity to exchange telephone circuits with satisfaction to all concerned.

In the case of the multiple-grounded neutral system the increased inductive influence results if current flows in the earth. The amount of such current depends of course upon the relative impedance of the neutral-wire path and the earth path, and also upon the amount of current unbalance of the system. The presence of harmonics in the earth-path current is especially objectionable from the communication standpoint.

As compared to the disadvantage outlined above, it was recognized that the multiple-grounded neutral system has an advantage over the single grounded system from the distribution standpoint. Should a break occur in the neutral wire an unbalance of the star voltages is presented if the system is multiple-grounded. Such unbalance under certain conditions may result in serious proportions.

From a consideration of these fundamental features, which have been briefly outlined, it is believed that the best results can be obtained if, in the design and operation of the 4-wire, 3-phase, multiple-grounded neutral system consideration is given to those features which will as far as practicable reduce to a minimum those effects which might otherwise be objectionable. For example, the disadvantages of the system from the inductive-influence standpoint are dependent upon the current in the ground connection rather than upon the ground connection itself. Certain features in the design and operation of a system will tend to minimize the amount of such current and some of these features will react to the benefit of both the supply and the communication utilities. At the same time others which may be of considerable importance from the communication viewpoint may not impose a burden upon the supply service. As an example of such features the following are recommended:

1. Single-phase loads so connected that phase balance will be obtained with relatively short distances.

2. These phase loads supplied by transformers connected Y-delta.

3. The neutral wire carried throughout the system on the same or adjacent crossarm, with the corresponding phase wire.

4. The length and load of single-phase legs not increased beyond a limit which is reasonably practicable in the provision of service.

5. The avoidance as far as practicable of the use on the system of equipment or equipment connections which may give rise to harmonic components of current or voltage, particularly components of the third harmonic and its odd multiples.

For those interested in further details relating to the inductive features of distribution systems they may be found in a paper on Power Distribution and Telephone Circuits which was presented by Trueblood and Cone at the A.I.E.E. convention in Seattle in 1925.

The committee wishes also to draw attention to the investigation of 4-wire distribution systems and communication lines which now are in progress by the joint general committee of the N.E.L.A. and the American Telephone and Telegraph Company. It is anticipated that reports on the progress of that work will be available in the near future.

Grounding on Consumer's Premises

The grounding of equipment on consumer's premises usually is in a large way governed by the same fundamentals that apply to substation and power-house grounding. For example, there came to the attention of the committee a condition where the transformers were located on a pole structure in an alley and the transformer cases grounded by means of pipe driven approximately 1 ft. distant from the property fence. The transformer failed and the current resulting from the failure passed from the ground pipe over the wire fence and from the wire fence to the house. The chicken wire which was used on the house to bond the stucco served to conduct the current to the water faucets. There was no damage done to the house other than at the faucets where the current density was in excess of the carrying capacity of the wire strands. At this point the chicken wire fused and exploded the stucco, damaging the stucco a distance of about 6 in. around the faucet. This only goes to show the importance of having a lower resistance path to ground near the distribution transformer than within the building of the consumer.

Comments by R. H. Cates

R. H. Cates of the Southern California Edison Company has had considerable experience in connection with the matter of grounding on consumer's premises and has been kind enough to give us the following report:

The practice of grounding one side of a 2-wire service, or the neutral of a 3-wire, single-phase service on consumer's premises has been practiced for years in many localities. The actual practice is to make this ground connection by attaching a wire to a terminal on the line side of the service switch and extend this wire to a pipe driven in the ground, a plate buried in the ground, or to the water pipes installed in the building.

During the period when open wiring was being practiced and central-station systems of large capacity seldom were encountered this practice, which was intended to limit the potential from lighting wires on consumer's installations to ground for the elimination of hazard to life, was quite satisfactory.

The rapid increase in development of central-station systems, electric railways and other utilities with their attendant network of transmission and distribution lines of greater capacity, and the adoption of an ironclad wiring job, present an entirely different problem. Grounds on service wires now must be maintained not only to protect the consumer from hazard to life, but in many cases from damage to property in case of high-voltage lines of considerable capacity coming in contact with service wires or secondary mains.

Different Methods

There are many ways in which a ground might be made on a consumer's installation, but the almost universal practice in cities along the Pacific Coast is to ground the conduit system and the neutral wire at the service switch. Fig. 5 shows an approved method of grounding at the service switch. In this case a pipe ground is run from the service switch box to a water pipe to which it is securely fastened by means of a clamp around the water pipe, with a threaded receptacle to receive the ground pipe. The service conduit in addition to being locked to the switch box by lock nuts also is connected to the ground pipe by a copper wire held between two spring washers by an additional nut, on both the service conduit and the ground pipe. A copper wire not smaller than No. 8 B.&S. gage, as specified by the National Code, now is run from the service switch terminals of the neutral wire to this same ground pipe. The smallest size ground wire permitted by the National Code is No. 8 B.&S. The neutral wire of a great majority of the small residence buildings seldom exceeds No. 10 B.&S. This necessitates placing two different sizes of wire under the same terminal screw resulting in a contact of very questionable carrying capacity to protect against what often is an excessive amount of current to ground; particularly during periods of failure of overhead lines in close proximity to secondary mains or service lines.

It is recognized by every one in touch with these problems that the above-stated fact is particularly true of the connections to the service wires that may be called upon to carry excessive current during failures on overhead systems and may, therefore, subject the consumer's premises to a considerable hazard if not able to meet that demand. Therefore it is the writer's opinion that insofar as grounds on the consumer's premises are concerned, they should be made both on the service conduit and on the neutral wire at the point of entrance to the building and not at the service switch. This ground should consist of a pipe attached to the water system and brought up to the service entrance at which point the service conduit and the neutral wire should be attached by separate copper conductors.

The writer has seen many cases where the ground wire had been burned off at the point of contact with the neutral wire inside of a building and several feet of service conduit within the walls of a building had been burned away, setting the building on fire. Many think that a conduit job of wiring eliminates fire hazard entirely. While this may be generally true on the load side of circuit fuses it is not true with the service conduit not so protected and especially with a neutral ground at the service switch.

An ironclad job of wiring, if not properly grounded outside of the building, often may constitute a fire hazard in the event of a breakdown in supply transformers of large capacity. Fig. 6. shows such an instance, where breakdown to ground inside of a consumer's installation started an arc across the disconnecting switches ahead of all fuses, burning holes in iron cabinets and service conduits and resulting in heavy damage.

The National Code at this time permits grounds at the service switch. Until such time as it is possible to get a dependable ground at the point of entrance to buildings it is the writer's opinion that secondary mains should have the neutral wires grounded at intervals along the line by running a pipe ground from water service pipes in the parking space to the nearest pole, extending this pipe a few feet up the pole and attaching it to a suitable ground wire, protected by wood covers, up the pole to the secondary mains. Without such permanent grounds on the secondary mains the breaking of a neutral service wire between the pole and a building would leave the premises unprotected except by the ground inside of some other building.

That might be some distance away and of very little carrying capacity by reason of poor contact usually found in such cases.

Discussion Invited

The section of this report covering Grounding on Consumer's Premises contains some rather radical changes from the present actual practices in the field. They are the result of the writer's conviction that better protection of consumer's installation is highly desirable if it can be obtained without too great an expense to the utility serving the consumer.

Conditions are changing rapidly as a result of expension of distributing systems, and grounding methods that were entirely suitable years ago no longer are suited to Pacific Coast conditions. The suggestions made in this report are the result of actual cases where service conduits have been burned up, causing damage to consumer's premises, where properly grounded secondary mains or grounds outside of the houses would have eliminated the trouble. These suggestions are not given as necessarily the best methods to adopt, but to bring about discussion along these lines from which may finally come some solution that will furnish adequate protection without unreasonable cost.

Grounding of Substations and Power Houses

As to station grounding, the points governing this class of work are pretty well covered in the fundamentals. The committee purposely avoided giving detail installations so that they might devote a greater amount of space to some of the principal points. It is believed that this procedure is better for the reason that if the requirements really are understood the matter of applying these principles to individual jobs is a mere detail.

Accident Prevention Committee Reports*

Identification of Cables

By P. F. MELNICK

Cable identification is one of the most important factors in underground work. Much of the safety to men and continuity of service depends on the absolute knowledge of the identity of each cable in a manhole. Unlike overhead conductors, where miles of wire can be traced, the underground cable is concealed and only exposed in manholes, vaults and on customer's premises. Therefore some method of identifying the conductors at the exposed locations must be taken into consideration.

When underground systems were very small a conduit system consisted of only 4 ducts, covering probably at most one sq. mile of territory. One man had full responsibility of it and it was rather easy for that one man to state with a great degree of accuracy what each conductor was. Even this probably was due to the standardization of cables, the number and size of one duct, and also the location in the system in question. Thus there was not the need of elaborate records in the offices nor extensive labelling in manholes.

However, in the larger cities underground systems are developing rapidly. In a system of this nature it is too great a task for one man to remember all the circuits and therefore all the different cables in the ground. Consequently a simple system of cable identification is necessary and very essential. It is a fact that a record not maintained properly and not kept up to date is worse than no record at all. Therefore it is absolutely essential that, if a record or system is established, it be maintained to the highest degree of efficiency. One mishap due to faulty records or to ignorance of cable identification may cause serious results.

Probably there is room for much improvement and development over the methods now used by the members of the Pacific Coast Electrical Association.

It is not enough just to have cables labeled in the manholes or to have just an office record; these two forms of identification must be worked in conjunction as accuracy can be assured only by a check system.

Questionnaire Reports

The following is a resume of reports received from members of the P.C.E.A. in reply to a questionnaire on cable identification. Nine member companies were questioned, only seven made reply and but five have an underground system. Therefore the following information is the author's interpretation of operating practices of the five companies.

It is general practice to tag some or all of the cables and also to keep some kind of office record. Each company, however, has its characteristic method of tagging and of keeping office records.

One company identifies its cables by means of either a sheet-lead tag or an embossed machine-made tag wiped onto the cable sheath. The tags give either the circuit number or information about the circuit. A system of circuit numbers is used to identify the kind of current and voltage, i.e., circuit Nos. 1 to 9, inclusive, represents 2.3-kv. lighting circuit fed from a 4-kv. grounded-neutral system; circuit Nos. 20 to 29, inclusive, indicate 3-phase, 2.3-kv. circuits, etc. This company uses the tags for feeders only; primary 11-kv. cables have a fireproof covering which at once identifies them. The office record is a schematic diagram of the manholes showing one-line diagrams for the circuits together with information as to the size, the number of the cable and the circuit number corresponding to the tag number. This record is called the "handbook" and is made up of blueprints each 3⅞x6¾ in. in size and bound in a loose cover.

Another company uses grass tags, tinned to prevent corrosion and securely fastened to the cable with brass wire. Differently shaped tags are used for the various currents and voltages. This is done to command immediate attention of workmen to the identification of the cable. Methods for distinguishing the different cables are as follows: high-tension lines are named according to the source and destination as, Vaca-Dixon-Claremont. 11-kv. tie lines also are designated by the source and destination with the circuit number; for example if a circuit feeds from station A to station B and if it was the first circuit it would be called AB-1, etc. Primary feeder cables are marked according to the source substation and the circuit number as, A-1, A-2, B-2, meaning substation A, circuit 1; substation A, circuit 2; substation B, circuit 2, etc.

Street-lighting circuits have 2-digit numbers. The first digit indicates the source and the second digit the circuit. For example, 22 means the circuit is fed from substation B and that it is the second circuit. D.c feeders have 3 digits, indicating the same as above except that the middle digit indicates the voltage.

After a man learns the system he knows accurately what each cable carries, where it feeds from and what it feeds. An office record also is maintained in the form of maps showing every cable in the ground.

A third company uses lead tags fastened with copper wire and with the cable information punched into the tags. The practice of that company is to tag only primary, high-tension and d.c. feeders. Secondaries and other lines are traced from some known point before working on them. In cases where identifying the cable is more difficult a fault finder is used to trace it from the substation.

A cable book is maintained for office record. All cables are recorded in this book giving the number and size of cable, the voltage, use and duct location. A record of this kind if accurate will give all the information necessary to identify any given cable to one who is able to interpret the duct location.

The fourth company tags all cables with lead tags made of scrap sheath with cable information stamped thereon. These are fastened to the cables with copper wire. The information on the tag tells the kind of current (primary, d.c., or secondary) and where it feeds.

A series of maps is maintained for office records

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* **J. M. Buswell**, San Joaquin Light & Power Corporation, chairman. **M. S. Slaughter**, The Southern Sierras Power Company, vice-chairman. **California Oregon Power Company:** S. M. Bullis. **Great Western Power Company:** G. W. Lyons. **Holophane Glass Company:** G. C. Rucker. **Los Angeles Bureau of Power & Light:** W. L. Smith. **Los Angeles Gas & Electric Corporation:** P. F. Melnick. **Pacific Gas and Electric Company:** S. C. Dickinson, C. A. Jordan. **San Diego Consolidated Gas & Electric Company:** W. E. Richmond, E. D. Sherwin. **Southern California Edison Company:** L. L. Dyer, S. C. Haver, Jr., D. J. Kennelly. **The Southern Sierras Power Company:** F. V. Wright. **Westinghouse Electric & Manufacturing Company:** P. B. Garrett.

showing the manholes and duct lines, also the primary, secondary and d.c. A record of manholes, with walls developed showing the number of ducts in a conduit section and service pipes leaving each wall also is maintained in the office.

The fifth company uses aluminum tags fastened to the cable with copper wire. Only primary cable, d.c. feeders and high-tension cables are tagged. Most cables are traced from a known point if doubt arises.

A map showing all cables in the ground is maintained in the office for record.

Conclusions

1. Identification often can be simplified by so building the duct section that each kind of current could have its alloted space and ducts. Thus in a 12-duct conduit system built 3 deep and 4 wide, the bottom row could be alloted to primary, the top to secondaries, and the middle row to d.c. cables. Direction also often helps to identify the destination and therefore to complete the identity of a cable. This method, however, is practical only in a newly designed underground system.

2. Standardization of cable size and kind is a very good aid to cable identification. For instance two 500,000-circ.-mil single-lead conductors and one 4/0 W/P wire in one duct would designate 110-220-volt a. c. Two 750,000-circ-mil single-lead conductors and one 500,000 circ.-mil bare copper in one duct would designate 110-220-volt d.c., etc. This method, too, would work only on a new system and where there is a concentrated load; otherwise it would mean a great expense for idle copper.

3. Painting stripes around the cable at conspicuous points in the manholes would aid in the finding of cables, especially where congested conditions prevail. For instance, red stripes around a cable to represent 500-volt d.c., yellow stripes to represent 220-volt d.c., blue stripes for 220-volt a.c., etc. This method would necessitate a constant inspection and repainting of all cables reused for a different current.

4. The above to be used in conjunction with the tags which carry the full information of the cable, as these are the only aids to identify the particular cable wanted. It is a fact that in a congested manhole where cable is nicely racked, the tags may not be legible except at close range and they often are in a position where one cannot get close enough to read them without removing the cable from the rack. Therefore the tags must be as legible and as lasting as possible and properly placed.

5. A tag should be placed at the time a cable is spliced, indicating the size of cable, kind of current, voltage, circuit number, source and destination; using a code system rather than printing or stamping all of the information on the tag. Where more than one company occupies a manhole each company should have a distinctive size of tag. Standard shapes of tags may be employed to designate different voltages and perhaps different kinds of current such as a.c. or d.c.

For tie lines between stations, letters corresponding to the source and destination stations together with the circuit number placed between these letters, seem to complete the requirement.

For main feeders the left-hand letter or digit can represent the station of origin, the second character a number representing the circuit and the third character represent possibly the direction or the zone or territory served.

A fourth digit character can be placed on a cable to represent the conductor used in the circuit where the circuit conductors are separate cables. Where it is desired to indicate the size of cable on the tag this may be accomplished by a character at the bottom of the tag, below all the others.

The splicer should attach the proper tag to the proper cable at specified and conspicuous locations. A report of the completion of the work, describing the tag, then should be returned to the office. After a circuit has been spliced and completed an inspector well trained for this work should be sent to inspect the splices and check the information on the tags. The original reports of the splicers should be recorded in the office daily and these records subsequently checked by the inspector's report. All cutovers or any necessary disturbance of splices or circuits should be handled in the same manner.

6. A systematized method for duct designation should be adopted. Several companies now are using a simple system of 2-digit numbers, the first digit representing the ducts from top to bottom and the second digit representing the ducts from left to right. For example, 22 indicates the duct in the second row down and second row from the left. Reference of course must be specified. Sometimes a prefix indicating the direction referred to is used, as E-22 meaning looking east. Another method similar to the above is to use letters for direction from top to bottom, and numbers for ducts, counting from the curb, on horizontal layers. For example, B2C indicates, B second row down and 2, second duct from C curb. In this system manner of facing is unimportant except for corner holes where streets must be specified.

7. A simple but complete record to be kept in the office with perhaps pocket-size sectional reproductions for field use. This record should show clearly and completely all duct sections and the developed wall arrangement of manholes; should show the duct designation, information concerning the number and kind of cables in each duct, cable designations, and the date of cable installation.

Data on the character of cable and its specifications together with dates of installation and other such information are valuable for engineering reference and also are necessary for accounting purposes at the time a cable is retired or replaced. On the up-to-the-minute accuracy of this record depends safety to the workmen as well as accuracy of engineering and accounting. It even is recommended that proposed work as well as completed work should be entered in such a record, but clearly distinguished as such.

8. A system adequate for the purpose should be established for accurately checking the tags placed on cables in manholes and for the maintenance of the same, for checking the entries in the records, and to insure that all tags and entries will be completed and check through not later than the end of the day following that on which a splice is made.

Apparatus and Devices

By P. B. GARRETT

Appreciation of the merit of apparatus and devices which make for increased safety is best evidenced by constant development, within the electrical industry, of new apparatus of this nature. Nearly every new electrical installation of appreciable size will be found to incorporate at least a few new safety features. In addition existing safety devices are being constantly improved.

One company reports the development of an interlock on its 60-kv. and 100-kv. potential transformers, that insures opening of the low-tension side when the high-tension disconnecting switches are opened to replace blown fuses. This is accomplished through the use of an auxiliary switch on the operating rod of the high-tension disconnecting switch, through which auxiliary switch the low-tension circuit is run. See Fig. 1.

In addition that company has developed a grounding switch for use on the transformer side of the high-tension oil and disconnecting switches that is so interlocked that it cannot be closed unless the latter are open.

A new type of insulating mat for use in generating stations and substations is being tried out at this time. This mat consists of suitably sized strips of battelship linoleum ¼-in. in thickness. This material is buff in color and can be obtained in strips 6 ft. in width and up to about 120 ft. in length. These mats are glued down and thus held permanently in place.

Certain disadvantages have been thought to exist in regard to linoleum mats. Among these is rotting due to moisture from a cement floor which has moisture under it. If the linoleum is cemented to the floor with the proper cement, moisture will not come through it and the linoleum will be protected. On the other hand, if the linoleum is not to be cemented, it can be treated on the under side with an insulating

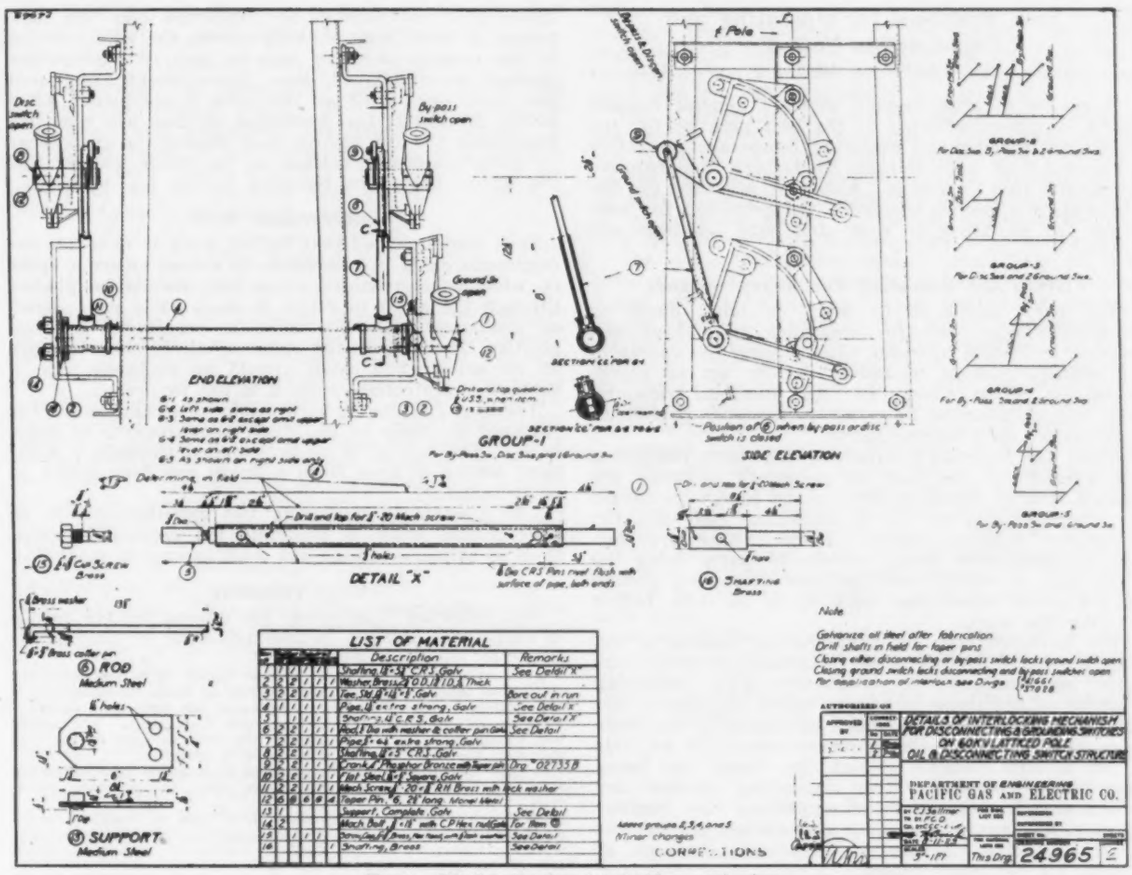

END ELEVATION
SIDE ELEVATION
DETAIL "X"
GROUP-1
LIST OF MATERIAL
DETAILS OF INTERLOCKING MECHANISM FOR DISCONNECTING & GROUNDING SWITCHES ON 60KV LATTICED POLE OIL & DISCONNECTING SWITCH STRUCTURE
DEPARTMENT OF ENGINEERING
PACIFIC GAS AND ELECTRIC CO.
This Drg. 24965

Fig. 1. Details of safety interlocking mechanism.

and moisture-proof coating which will protect it reasonably. In any case the linoleum should be treated on the top surface so as to keep dirt and moisture, from the top, out and also to make it easier to keep clean, and this matter of cleaning was supposed to be a disadvantage.

A very good form of wooden mat is made up of hard-maple insulating strips doweled together and constructed with beveled edges. The absence of any bolts or screws eliminates any possibility of an operator tripping upon any such that might be projecting from the surface.

The enclosing of switches having exposed live parts goes on steadily. When ventilation is important a transite board is mounted on supports and arranged to cover the front of the switch, but leave it open on all sides. Double-throw knife switches are equipped with circular shields that leave only the operating handle exposed.

In some cases the covering of exposed live buses in the rear of switchboards is accomplished with strips of micarta board, cut to proper size and usually either L or channel-shaped. This makes a very attractive protective covering.

There is a very live demand among the operating companies for some kind of an instrument or device for "detecting" or "proving" a conductor to insure that it is dead before grounding it. Likewise there is the need of a device to indicate approximately the voltage of a circuit or whether the current is alternating or direct. In this regard it should be pointed out first that no safety device that has any possibility whatever of failure should be used in this manner.

The use of indicators of this type was started first about four years ago when the Neon tube indicator known as the Spark-C was brought out. At that time an investigation was made of the Neon tubes as indicators for use on high-voltage transmission lines and high-voltage bus bars. Tubes using this principle as made up in a research laboratory were very successful. The design then was turned over for production on a commercial basis. It was found that they were all right until such time as the vacuum in the glass tube was lost. Loss of vacuum is caused by the burning of a hole in the glass; that in turn is found to be due to the use of Neon which has not been suitably washed.

As a result it has been decided that these tubes should not be used as safety devices, but merely for indicators. They are used today for bus-bar indicators eliminating high-potential transformers. Although these tubes are not positive indicators, likewise the high-voltage potential transformer is not an absolutely positive indicator as the winding may become open-circuited, in which case a bus is indicated as being dead when it is not. A gold-leaf electroscope sometimes is used as an indicator for this same purpose, but again it is not an infallible device.

About eight years ago a high-voltage indicator was brought out consisting of a set of vanes on the end of a stick. These vanes were held in the vicinity of the line in question and if the line were "hot" the vanes rotated due to the electrostatic field. This device was a failure because friction developed in the bearing of the device and the vanes would not rotate when they should. This, of course, also gave a false indication as to a line being dead when it was not.

Another indicating device for lower voltages makes use of resistances in series with lamps. As a safeguard against false operation of this device two lamps are used, connected in parallel. It has been suggested that if test lamps are used they should be housed in fine wire-gauze cages or in housings provided with narrow slits through which the lights can be seen.

The "buzz-stick" method is considered to be one of the surest methods of testing a line to ascertain definitely whether it is or is not energized.

Regardless of the device used to test a conductor for potential it is recommended that where possible the device be applied to a known live conductor, as a check on its operating condition, both directly before and directly after making the test on the conductor in question.

Safe Practices for Operating and Construction Forces

By W. L. SMITH

A review of requirements shows a general demand for a statement of what is the best practice for the following: placing and removing temporary protective grounds on high-voltage conductors, underground work, and tree trimming. Also safe practices for the elimination of minor accidents and provision for penalties for violation of rules and safe practices are desired.

Placing and Removing Temporary Grounds

The party about to do work on lines, buses or equipment must call for clearance from load dispatcher or system operator, thus placing the operation on record. Station operators usually act as representatives of the dispatcher. On overhead transmission and distribution lines the foreman or patrolman may act as such representative.

After the necessary switching has been completed and checked to see that all necessary switches are opened Men at Work or Men on the Line tags should be placed on controls of all switching gear and the permanent station grounds closed where provided. The representative should inform the party doing the work that he must place his own short and ground at the point where the work is to be done before starting the work.

The workmen then must proceed by making a test with a switch hook or some instrument of that character by touching the conductors and observing whether or not there is a snap which indicates a hot conductor. This test operates satisfactorily for voltages above 6.6 kv. For voltages below 6.6 kv. this is not a very reliable method, the "snap" not being pronounced enough. Other indicating devices are recommended such as those employing the familiar spark plug testing tube which glows when placed near a live conductor. A suitable handle must be used, of course, for any such device.

In using any of these devices it is recommended that either the arrangement in duplicate should be used or the instrument used should be checked to a known live conductor before and after exploring the conductor being checked. This is for the purpose of making sure that the device is working and to assure that it doesn't give a false result.

In placing temporary grounds on conductors to be grounding is a flexiblee cable with one end connected to until they have been securely grounded. For protection workmen should stand well below or to one side of the part to be grounded in order to keep away from any arc that may arise in case the bus or line should be charged when the ground connection is being applied. In all cases the grounding cable must be satisfactorily attached to ground before the clamps are taken to the conductors and in removing grounds detachment must be from the conductors first.

The arrangement recommended for temporary grounding is a flexible cable with one end connected to any approved clamping arrangement for connecting to a permanent station ground, water pipe, or tower frame which is known to be grounded to earth. On the other end of the cable is provided a clamp mounted on an insulated handle of any desired length. This clamp is so arranged that when it is hooked onto the line it may be screwed up tight to eliminate the possibility of its becoming unfastened and in order to improve the contact.

In isolated locations such as on lines or in stations in the country or where there is no regular operator it is recommended that two experienced men work together in the placing of temporary grounds. One should station himself sufficiently far away so that: first, he will probably not have just the same thoughts as will the man actually doing the switching; second, from his wider range he can see more of the structure and can better check what the operator is about to do; and third, so that he would not be involved if an arc is caused, but will be safe and able to render assistance.

It has been recommended that where megger or other testing is to be done, requiring that the conductors or devices be ungrounded at the time, the above procedure should be completed and the temporary grounds removed only during the actual period of the megger or other type of test, the temporary grounds re-established, then, immediately afterwards and maintained until all the work is completed, after which, of course, the grounding devices are removed, first from the conductors, and finally the dispatcher or system operator notified in the usual manner and the entire procedure recorded in the log books.

Underground Work

It is recommended that before work is done on underground cable in a manhole or tunnel either a spike or wide chisel mounted on a long handle be pushed through the cable to prove it dead. The wide chisel as compared with the spike is considered a more positive check unless the spike definitely shows copper on its sides. The chisel should be equipped with a boot as a protection when it is not in use.

The required use of hose masks is recommended for entrance to smoke or gas filled compartments or manholes. The use of a mask supplied through a sufficient length of hose from a pump has been found to be satisfactory.

The practice of employing two experienced men in underground work is recommended especially where there is primary-voltage bus work located in manholes.

Tree Trimming

The following suggestions are offered for the safety of employees engaged in tree trimming in close proximity to high-voltage lines:

1. Men should be required to use safety belts and climbing irons and not depend upon the security of limbs to either climb or stand on. The climbers recommended for soft wood or thick bark should be about 17 in. long with 4-in. gaffs. The safety belt should never be placed around the limb or part of the tree to which the hand line or other rope is attached.
2. The standard tree pruners should be equipped with operating rods of an insulated material rather than the ordinary metal rods.
3. Where a cut is to be made on a limb or trunk of large diameter the operation can be done safer to the employee and with less injury to the tree itself by lashing or binding on either side of the place where the cut is to be made.
4. At least two or more experienced men should work together in carrying out the operation, depending on conditions.
5. Any branch that is lying against a primary line of 2,200 and 4,400 volts should be first pulled away before being cut. In a case of cutting limbs away from lines of voltages from 10 to 33 kv. a clearance from the load dispatcher should be obtained.

Elimination of Minor Accidents

Constant atteniton of the management to those details which tend to eliminate waste or inefficiency also will eliminate those conditions which cause acciden Good housekeeping in all departments, especially in the shop, warehouse, substation or on construction work is an important factor. This means constant inspection and constant appeal and instruction to men.

It has been found by those companies that provide first-aid kits in all quarters, and especially on all line trucks, that to emphasize minor injuries by requiring the foreman and straw bosses to see that every minor injury is given first aid treatment (iodine if nothing else), and that they be covered by accident reports so focuses attention onto even minor injuries that the men avoid them whenever possible if for no other raeson that to eliminate the bother.

The use of laminated-lens goggles is imperative on all work where there is a possibility of flying particles lodging in the eyes. Notices should be posted in perament form at all emery wheels to convey to the workmen the necessity and rules for wearing goggles.

The requirement by all companies of physical examination at least of employees engaged in dangerous work will go a long way toward the elimination of accidents.

Penalties

The public utility finds it necessary to provide safeguards and protection for its employees in the carrying out of hazardous work. Lest there should be any wilful disregard on the part of the employees toward this safeguarding, definite penalties for violation of certain fundamental and highly important practices have proved successful. These are generally stated in the rule book and involve dismissal, demotion and other penalties. For violation of less vital but nevertheless important rules it should be stated in the

rule book that penalties may be imposed, in order that chronic violators may expect to be penalized.

General Safe Practices

Engineering and purchasing departments of the public uitlity should include in all specifications for machinery and equipment that such machinery or equipment must be provided with proper safeguards and that before such machinery or equipment is accepted by the company it shall have an inspection relative to its proper safeguarding.

The Foreman

By W. E. RICHMOND and E. D. SHERWIN

The position of the foreman in industry, with regard to safe practices, is much like that of the schoolteacher in relation to the community. His influence over workmen is exactly that of teacher over pupil, but with more authority than the teacher. His responsibility to the management is precisely that of the teacher to the community for upon his understanding of and belief in what he teaches depends the results accomplished by workmen at his command. Results attained by foremen are proportionate to their correct application of their knowledge to the situation they control.

Foremen are deliberately chosen because of their possession of ability to apply requisite knowledge to practical ends. Thus when the management decides that workmen shall be taught to discard old and adopt new habits of thought and action the foremen are depended upon to effect the desired changes.

Experience has demonstrated amply that accident-prevention and first-aid measures rightly carried out will pay dividends. Hence it becomes desirable for foremen to acquire knowledge of one and of its application to produce the other. This calls for instruction of foremen to the extent that they shall influence their workmen to observe habitual obedience to rules and in turn to be receptive to instruction and its application.

To develop and maintain habitual safe practices and proper rendition of first aid involves the selection of instructors who will impress on foremen: first, the humanitarian aspects; second, the money or economic value to the workman; third, the money or economic value to the company of stopping accidents; fourth, the commonsense attitude that it pays from any and every point of view to form habits of safety.

The foremen must secure attendance of workmen at class instructions.

When both foremen and workmen have received instruction persistent effort must be directed toward keeping up interest always. Methods for doing this vary, but may include:

1. Class work, committees, meetings, contests, examinations, prizes.
2. Use of house organs and bulletins.
3. Issuing of first-aid and safety rules, instruction books and other printed matter.

In actual practice of first aid the necessity for immediate attention to slight injuries is the most difficult thing to get workmen to realize. Here, the foreman's right attitude is invaluable. The new employee also must be brought into line.

Safety habits once fixed lend their tone to the establishment just as carelessness is noticeable or slovenliness is a marked characteristic of some plants. The properly trained foreman who breaks rules should be penalized. The same for workmen. Rules should not apply to men not capable of obeying them.

How many firms know whether or not their foremen and workmen can apply instruction if given them? How many know, have records in black and white showing what has been done and who has been instructed and how well? Examine them and then make your rules to fit.

Safety Bulletins

By M. S. SLAUGHTER

Emerson says nine-tenths of our education is received through the eyes. Accepting this as true, no other medium offers the opportunity for education in accident prevention work that is presented in safety bulletins. To be effective these bulletins must carry a message that is pertinent to the industry and easily understood by the employee to be reached. The most attractive size is 8½x11 in., with reading matter very brief and presenting a single thought.

The bulletin idea is growing rapidly and numerous sources of supply are available. Those prepared by the National Safety Council, various insurance companies and power companies present a wide choice of good material. The first offers the best selection of appropriate matter at the most reasonable cost and is the prevailing choice of member companies.

The use of company designs exclusively is very attractive and offers opportunity to follow up educational work of a special nature, but is not available to the smaller companies which have no personnel department to properly prepare the bulletins. To these companies the use of locally prepared bulletins of a cartoon or special nature, as an auxiliary, may be enlarged as facilities and supervision permit and will increase the value of the safety-bulletin education.

Interest manifested by employees is very favorable to well selected bulletins and the effectiveness is observed in the care exercised by all classes of employees in following the message delivered. This interest is greatly increased if the bulletins are conspicuously posted on well designed bulletin boards and changed at regular intervals, preferably every two weeks, by someone specifically designated to care for this work.

Safety bulletins hold a high position in accident-prevention education and it is important that due consideration always be given to any improvements in design and methods of handling, in order to maintain proper interest of the employees.

Tools

By J. M. BUSWELL

The purpose of this paper is to present for the benefit of member companies any tools or appliances that may have been developed on any of the systems to promote safe and efficient operations. It is true that we cannot furnish the prime requisites among tools, namely, eyes that see and brains that always think first. Still we may develop these in the individual by education. By attention to tools we can help secure safe working conditions.

Many times appliances are avoided or mistrusted by the men because of some defect in design or construction. If those in charge of accident prevention will familiarize themselves with processes of the work they can detect, from their broad knowledge of other cases, the defects in equipment that lead to accidents.

Because of the close contact between the accident prevention man and the entire personnel of his organization he has exceptionally good opportunity to iron out defects or shortages in equipment. He has or he should have the confidence of the men, learning their viewpoint. This close contact is evidenced by the wide variety of ideas submitted in response to our request for data.

To combat the desire of linemen to get their safety belts made as cheaply as possible and in accordance wth their own ideas by the nearest harness maker the San Joaquin company developed a standard safety belt and strap, after consultations between its linemen and inspectors. Fig. 1 shows this belt. The following specifications eliminate unsafe materials:

General

All parts shall be of style shown on the attached drawing.

All dimensions shall be as shown on the attached drawing.

The size of the belt shall be that dimension, stated in inches, from the end of the buckle to the middle hole in the tongue of the belt.

Details of material and manufacture shall be as specified herein or shown on the drawing.

Tests shall be made as specified herein and shall constitute an acceptance test. They shall be made by the purchaser in the presence of a representative of the manufacturer if possible.

Material and Manufacture

Leather in belts and safety straps shall be first-quality genuine oak-tanned leather from northern steers and shall be cut from the backs of the hides only. The minimum thickness shall be 3/16 in.

No splices shall be allowed in belts or straps.

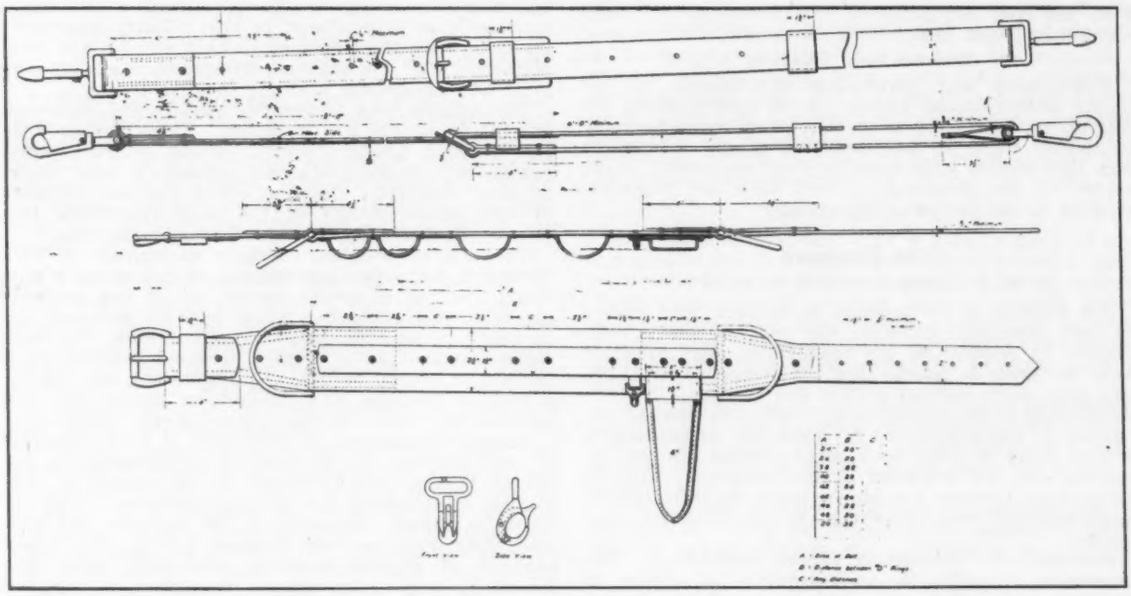


Fig. 1. Standard lineman's belt and safety strap as designed by the San Joaquin Light & Power Corporation.

Holes shall be punched as shown in the drawing and no hole shall exceed ¼-in. in diameter.

Thimbles shall be used on "D" rings and fixeed snap. The other snap shall be equipped with a metal roller on the bar at least 1/16 in. thick and the full width of the snap. "D" rings shall be fabricated of one piece of good quality steel, drop forged and galvanized. They shall be perfectly smooth, no sharp edges being permitted. They shall stand a tensile test of 1,200 lb. without deforming.

Buckle frames and tongues shall be fabricated of good quality steel by drop forge method and shall be galvanized. They shall be perfectly smooth, no sharp edges being permitted. Snaps shall be of good quality steel, drop forged and galvanized and the snap hook as assembled shall consist of a body, keeper latch, spring and roller, and shall be adjusted to work smoothly. They shall be equipped with thimble and roller as stated above under 'Thimbles.' They shall work over curved portion of the "D" rings from any angle without interference or tendency to bind.

Rivets. Only solid copper rivets, of a minimum diameter of ⅛-in. hand-set with copper bars shall be used.

Stitching shall be done with genuine 5 or 6-cord Irish linen thread, hot waxed, and shall be what is known as lock stitched. The pitch shall be not less than five or more than six to the inch. Stitching parallel to the edge shall be not less than 3/16 in. and not more than ¼ in. from the edge of the narrowest member caught by the thread. There shall be no stitching across the belt or strap.

Tests

The completed belt and safety strap shall stand, without injury to or deformation of any part, the following tests:

1—Belt shall be buckled around a fixed circular form approximately 12 in. in diameter. Both snaps of safety strap to be fastened in one "D" ring and loop of strap passed over a movable circular form about 6 in. in diameter. This movable form is to be weighted, or stress applied by other means until the stress applied to the belt and safety is 1,200 lb.

2—Above test is to be repeated with safety snaps in the other "D" ring.

3—Belt and safety strap to be tested as above except that safety strap snaps are to be fastened one in each of the "D" rings and stress of 1,750 lb. applied to the belt and safety.

In this connection it is mentioned by this company that the necessary hardware can be secured from manufacturers other than those making complete belts, as those manufacturers often refuse to sell the hardware separately.

The use of web or cotton belts is recommended only where all-creosoted poles are worked on. Creosote burns or dries the life from leather whereas web belts can be taken care of so that they do not fail as quickly.

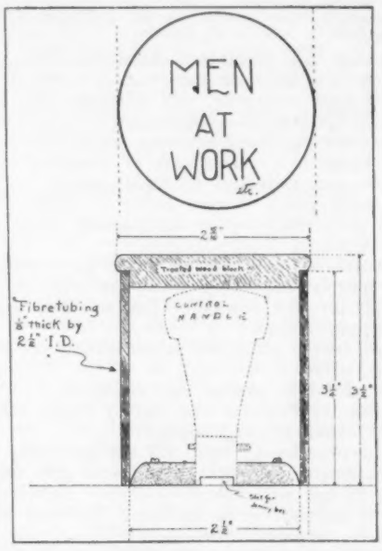


Fig. 3. Details of switchboard pull-button safety cover. Block is red, letters are white.

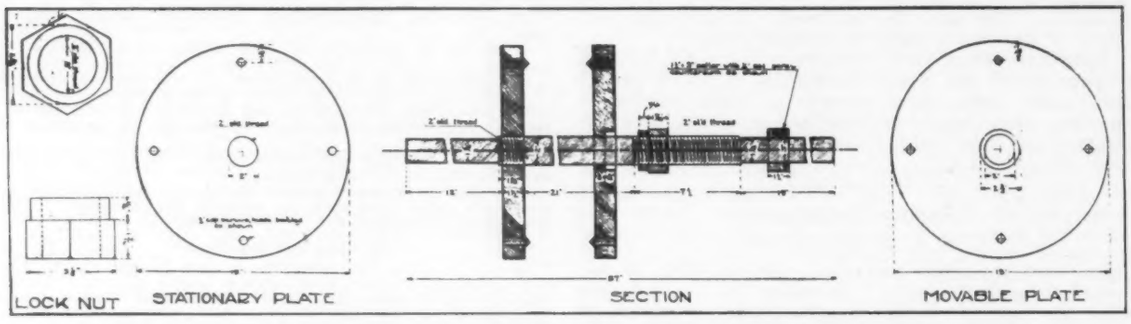
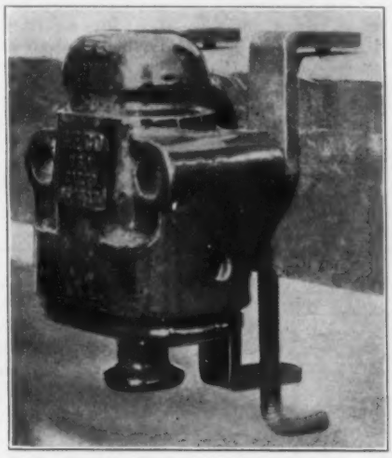


Fig. 2. Adjustable cable-reel shaft as designed by B. McPhee of the Southern California Edison Company.

Prevailing Practices

The Los Angeles Gas & Electric Corporation does not permit a lineman to use his own tools. A complete set is furnished him; tools, belts and other necessaries are loaned to him while in the employ of the company.

The Pacific Gas and Electric Company is also adopting a policy of furnishing hardware to a man where



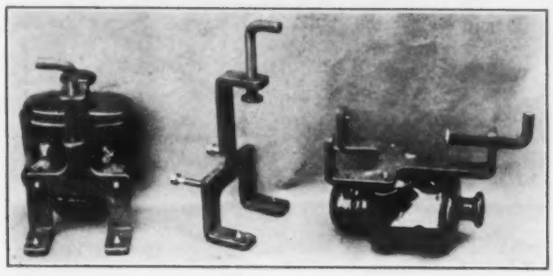


Fig. 4. Below, three views of safety emergency mounting for primary cut-out as developed by the San Diego Consolidated Gas & Electric Company. Above, same mounted on crossarm.

he cannot or will not replace a tool or other equipment that has been condemned.

In other words it is being recognized that it is not sufficient to condemn a man's equipment and leave it to him to get other the best way he can. Substitutions must be taken care of to the man's satisfaction.

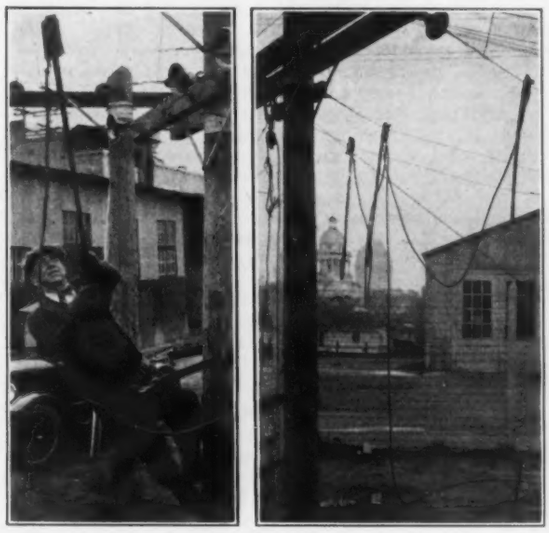


Fig. 5. Grounding clamp devised by San Joaquin Light & Power Corporation.

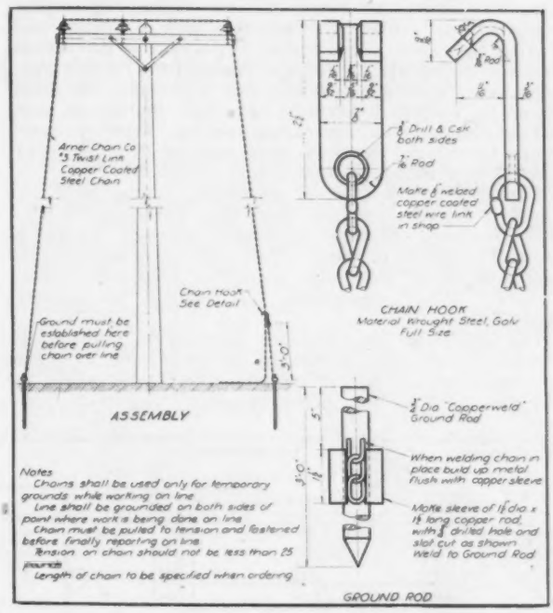


Fig. 6. Grounding practice of Pacific Gas and Electric Company where grounding chain is used.

To promote the lineman's confidence in gloves and to insure their constant care and availability some companies issue an individual pair to each lineman. The Southern Sierras Power Company reports that this scheme promotes greater confidence on the part of the men and better conditions of the gloves are noted when they come in for tests. That company's specifications for a bag suitable for hanging on the lineman's belt provide that the bag be made of 8-oz. duck 18x8 in., sewed flat, and pointed flap fastened with a substantial button snap. On the reverse a small swivel hook is fastened.

The question of how often gloves should be tested and to what extent they may be weakened by high-voltage tests is covered in another paper. There is no doubt that a pin prick may not show up in the air test although it may fill up with perspiration. However, many high-voltage tests may do considerable damage by over-stressing the rubber.

Safety Devices

From the Southern California Edison Company comes the reel-clamping device illustrated in Fig. 2. This device is of great value in that it will handle successfully that bug-bear of the line gang, a damaged cable reel.

The Southern California Edison Company also uses the switch-button cover shown in Fig. 3. This slips over the control button on a remote-control switchboard to prevent a switch being closed when clearance has been given beyond the switch.

The San Diego Consolidated Gas & Electric Company uses the clamp for a primary cutout shown in

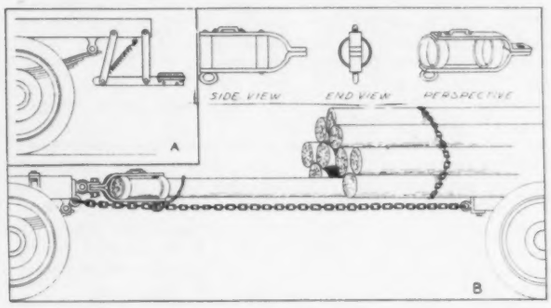


Fig. 7. Above, non-rigid rear step for line trucks; avoids breakage. Center, details of pole-muzzle towing attachment. Below, application of pole-muzzle towing attachment. Equipment devised by Geo. Hamminger of the Southern California Edison Company.

Fig. 4. This was developed as emergency repair equipment to replace the cutout where a failure had burned the arm. The device obviates the dangerous practice of cutting-in solid a transformer which perhaps has a damaged winding, but it permits the same speed in restoring service. In this connection discussion among the representatives of member companies develops the fact that use of this type of transformer cutout is fast being obviated.

Fig. 5 shows a type of grounding clamp built by the San Joaquin company and Fig. 6 shows the Pacific Gas and Electric Company practice where a grounding chain is used. This company also makes extensive use of grounding clamps of their own manufacture. Other companies use clamps of outside manufacture.

The procedure in installing grounds is covered in another paper, Safe Practices, but it is well to point out here that the use of clamps gives more safety to the man working behind the grounds. The chain prekept in proper condition. In other words, as with all apparatus, frequent inspection is required.

A form to store the mask on to hold it in a shape similar to the human face will prevent the mask from taking a set in such a shape that it will not fit easily when used in emergencies.

The matter of safe transportation of men and materials occupies the attention of all, and in increasing amount.

The Southern California Edison Company supplies a sketch, Fig. 7, of a flexible step for a truck. This step should not be put out of service due to collisions with the warehouse platforms as regularly as is the rigid step.

From the same company comes the pole muzzle shown in Fig. 7. That device provides a flexible and suitable coupling to a trailer-load of poles.

The Pacific Gas and Electric Company uses the cable-splicer's platform shown in Fig. 8; requiring that belts and safeties be worn where a platform not

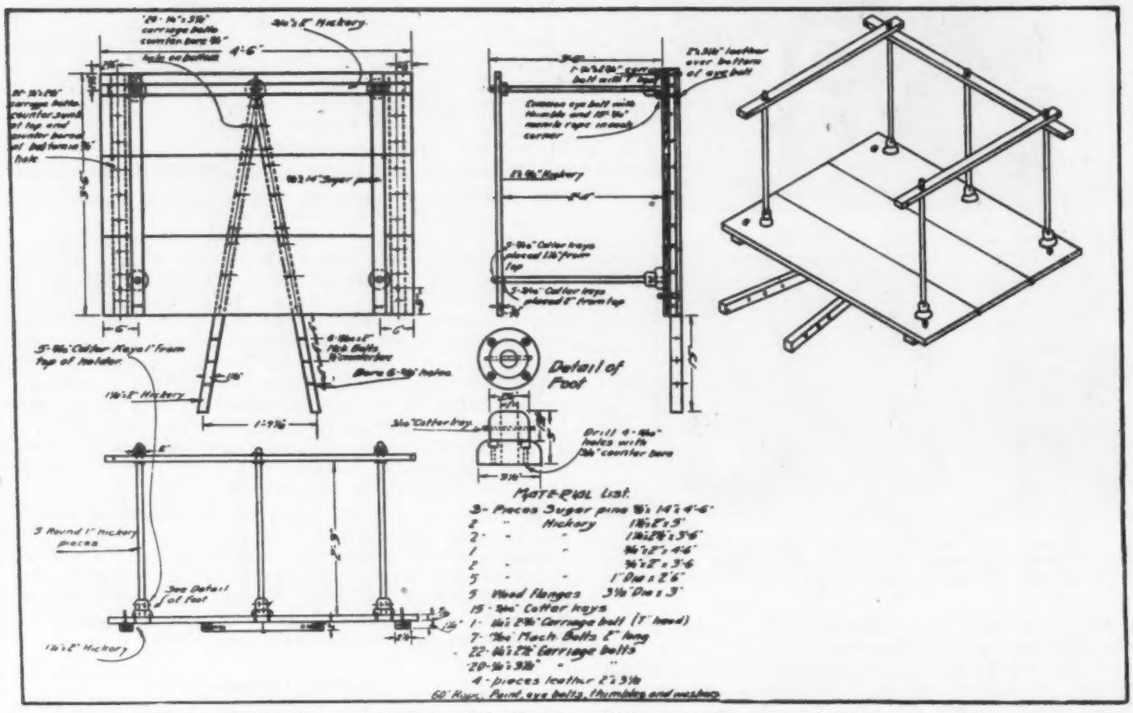


Fig. 8. Cable-splicers' chair designed by East Bay Division, Pacific Gas and Electric Company.

sent the hazard of contact with other lines while being thrown over and also gives only a point contact which a little dirt easily may destroy. Many accidents have resulted from attempts to loosen a caught chain as it is bulgy to handle.

Furthermore, the clamp on the end of an insulating handle allows the operator to "feel out" a line to make sure it is not energized, sometimes preventing a burn-down of the line.

To definitely prove out an underground cable before cutting into it, several companies provide a spike or chisel. The Pacific Gas and Electric Company uses a 2-in. steel chisel blade on the end of a 6-foot wooden pole. They require, to be sure that the conductor is contacted to the sheath, that the blade show copper markings upon withdrawal.

In this connection it seems to be the practice of member companies to use hose masks for manhole work where required. This obviates the difficulty due to aging of the chemicals of the cannister types and insures better protection against leakage of gases in around the edges of the mask. The outside pump gives a positive air supply to the interior of especial value if the mask is poorly fitted to the face.

Naturally, for station use the cannister type is required where compartments and corridors must be traversed, sometimes rapidly. In this connection it is pointed out that the harness of the masks must be equipped with railing such as this is provided. A man is no safer on a platform or dead-end board without belt or railing than he would be on a stepped pole or crossarm. If the splicing tools are provided with hooks and kept hung up there will be no necessity for a toe board around the platform.

In soldering equipment there is a tendency among several of the member companies to supersede the gasoline torch by acetylene. Harnesses have been devised to hold the tank suspended on the crossarm so that the valve always is accessible, the hose nipple protected and the tank pointed away from the men and equipment. In this connection it has been pointed out that a shut-off wrench, preferably of the socket type, should be chained to the tank for emergency use.

It also has been brought out that a non-corrosive soldering paste is safest and easiest to use and that a compartment attached to the gas-tank holder is desirable as a paste container.

Conclusions

In conclusion it cannot be over-emphasized that a prime duty of those charged with accident prevention is at all times to co-operate in the development of new tools and devices for promoting both safety and efficiency. Efficiency and safety go hand in hand and a tool designed for safety nearly always promotes efficiency.

Overhead Systems Committee Reports*

Study of Life of Treated and Untreated Poles

By R. E. CUNNINGHAM**

The subject of the relative life of treated and untreated poles is being considered by several geographic divisions in co-operation with the national overhead systems committee. The following report gives the results of the investigation of the P.C.E.A. subcommittee studying the subject.

In order to obtain figures which would be representative of conditions throughout the entire state of California the subcommittee was composed of members from the following companies: San Diego Consolidated Gas & Electric Company, The Southern Sierras Power Company, Los Angeles Gas & Electric Corporation, Los Angeles Bureau of Power and Light, Southern California Edison Company, San Joaquin Light & Power Corporation, and Pacific Gas and Electric Company.

Probably these companies have a total of approximately a million wood poles in service. To attempt to investigate and report on all these poles would be impracticable. It was decided, therefore, that each member would select certain lines of poles the history of which was known and which were fairly representaive of conditions in the respective locations, and inspect same. A compilation of all such reports should give a fair average of results obtained throughout the state.

Practically all poles used by the Pacific Coast companies have been western red cedar from Oregon, Washington and Idaho. In earlier years these poles were set untreated while in more recent years they have been butt-treated by the open-tank method. Some of the companies have used a few poles of native cedar, pine and tamarack, but the supply of such poles is limited and the life has been short so that a report on these would not be of material value.

During the war period some use was made of butt-treated Douglas fir. In view of the very large supply of this timber in the Northwest and the possibility of using it full-length pressure-treated the results obtained thus far should be of interest.

Before presenting the reports of the various companies attention should be given to a special test of treated and untreated western red cedar conducted by the U.S. Department of Agriculture, Forest Service, which began prior to 1909. This is the most valuable and authentic record we have on this matter, as the experiment has been under the direction of government experts from the beginning and most careful records of seasoning, treating, inspections, etc., have been kept.

Forest Service Report

The preliminary report of the 1925 inspection has just been received and is as follows:

In 1907, 1908 and 1909, 891 experimental 35 and 40-ft. western red cedar poles were set in and around Los Angeles in the lines of the Los Angeles Gas & Electric Corporation, Pacific Electric Company, Southern California Edison Company, Home Telephone Company (now the Southern California Telephone Company), and the U.S. Long Distance Telephone and Telegraph Company. In 1922 the city of Los Angeles, through its Bureau of Power and Light, took over the city lines of the Southern California Edison Company, and now is maintaining the experimental poles in those lines.

Experimental seasoning and treating were conducted at Wilmington, Calif., by the Forest Service in co-operation with the various companies. The poles were cut in northwestern Washington and were about seasoned upon arrival at Wilmington. There they were seasoned for an additional three to nine months before being treated. Both open-tank and brush treatments were used.

Average absorptions with the different treatments may be found in the accompanying analyses of the preservatives in the appendix. (Table and analyses not shown in this report.) The creosote was purchased as a coal-tar derivative, but tests of specific gravity, index of refraction, and sulphonation residues indicate that it was a water-gas tar product.

Inspections of the poles were made in 1910, 1911, 1912, 1913, 1916, 1920 and 1925. The results of the first five inspections never have been published. The 1920 inspection results were discussed in Mr. Hicks' paper, and the results of the 1925 inspection will be presented here.

Although 891 poles were set originally, data for only 446 are summarized in Table I, 445 having been eliminated from the study; some because they were destroyed, others because they were set too deep, that is with the ground line above the treated area, others because they were set in concrete making it impossible to inspect them thoroughly, and still others on account of new construction and changes in lines. It is for the last-named cause that the highest percentage of poles has been eliminated. The growth of Los Angeles since the establishment of the test lines has been very rapid and the companies have had to make many changes in their old lines and construct many new lines. The result is that a large number of the experimental poles have been removed without record having been kept of their condition or disposal. For instance, during the summer of 1922 the pole line of the U.S. Long Distance Telephone and Telegraph Company extending from Los Angeles to Whittier was replaced by underground cable. About 167 experimental poles were eliminated as a result of this change.

Tank creosoted poles were found in the best condition. About

TABLE I.—Condition of experimental western Red Cedar poles in and around Los Angeles after about 16 years service. Results of 1925 Inspection*

Preservative	Treatment (Butts only)	Condition	No. of poles Set	In test	Eliminated**	Sound No.	Sound Per Cent	Partly decayed No.	Partly decayed Per Cent	Removed on account of decay No.	Removed on account of decay Per Cent
Carbolineum	Brush	Seasoned	59	31	28	2	6.4	18	58.1	11	35.5
Creosote	Brush	Seasoned	68	29	39	1	3.5	17	58.6	11	37.9
Creosote	Open tank	Seasoned	471	244	227	184	75.4	55	22.5	5	2.1
Crude Oil	Open tank	Seasoned	5	..	5	..	..	..	..	..	..
Zinc chloride	Open tank	Seasoned	175	76	100	1	1.3	60	79.0	15	19.7
Zinc creosote	Open tank	Seasoned	56	34	22	5	14.7	24	70.6	5	14.7
..	Untreated	Seasoned	56	32	24	..	..	15	46.9	17	53.1

*U. S. Department of Agriculture, Forest Service, Forest Products Laboratory, Madison, Wisconsin, January 18, 1926.
**Eliminated on account of removal for new construction without record of disposal; poles set too deep; set in cement or other places where a careful inspection could not be made; burned; broken by accident, etc.

The creosote was purchased as a coal-tar derivative, but tests of specific gravity, index of refraction, and sulphonation residues indicate that it was a water-gas tar product.

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** **Report of Subcommittee. R. E. Cunningham,** chairman; K. B. Ayres, E. R. Banks, F. E. Dellinger, H. L. Caldwell, N. B. Hinson, R. W. Muller, E. Y. Porter, J. O. Tobey.

75 per cent of them showed no decay at or near the ground line after 16 years service, and only about 2 per cent had been removed on account of decay.

Poles treated with zinc-creosote were in better condition than those treated with straight zinc chloride. No appreciable difference existed in the condition of the poles brush treated with carbolineum and with creosote although both groups were in poorer condition than any of the other treated poles. About 53 per cent of the untreated poles had been removed on account of decay and those still in service were decayed to some degree.

A factor which appears to be at least equal in importance to decay in affecting the life of untreated and butt-treated poles in southern California is the attack of termites on the untreated areas. A high percentage of the experimental poles are so affected to some extent. It was possible to observe carefully the condition of the poles only for a distance of about 8 ft. above the ground line except when the poles of the Southern California Edison Company were inspected and a lineman was detailed to assist. From the results of inspections and observations it is believed that a high percentage of the butt-creosoted poles eventually will be removed not on account of decay at and near the ground line, but on account of termite attack above this area. It is quite likely that the same will be true for the poles butt-treated with zinc chloride and zinc-creosote, but most of the untreated and brush-treated poles probably will be removed on account of decay or a combination of decay and termite depredation.

With the termite as active as it is at the present time in southern California, the consumer will be practicing poor economy to use a good butt treatment, such as the open-tank creosote treatment for instance, and fails to provide protection for the top. If, however, only a brush treatment of the butt is used it appears a mere extravagance to treat the tops as the butts probably will be rotted through before or at least as soon as the top is severely damaged by the termites.

San Diego Consolidated Gas & Electric Company Report

In speaking of untreated poles those to which no treatment of any kind has been applied are indicated.

Creosote-brushed means creosote painted on with a paint brush; a method of application that gives very little penetration.

Creosote-tanked means that the poles have been treated to a height of about 8 ft. above the butt by standing upright in a tank of imported creosote heated to a temperature of from 250 deg. to 300 deg. F., and allowed to remain form 16 to 18 hours, the creosote being allowed to cool during this time. Penetration due to this treatment on red cedar is approximately ½ in.

The lime-mortar treatment is a mortar made of lime, sand and rock, applied to a depth of about 3 ft. below the surface of the earth, forming a jacket around the pole similar to the cement jacket applied for reinforcing purposes, but of course having no reinforcing irons.

Inspection Results

December 15, 1925. 33 poles set in 1917 and located on Thirty-second Street, San Diego, and in Camp Kearny Mesa, north of Mission Valley.

Height—
12 poles, 50 ft.
21 poles, 60 ft.

Top Size—
1 pole, 9 in.
24 poles, 8 in.
7 poles, 7 in.
1 pole, 6 in.

Variety—
18 poles, Douglas fir.
15 poles, red cedar.

Treatment—
9 cedar poles, lime mortar.
5 cedar poles, creosote-tanked and lime mortar.
15 fir poles, creosote-tanked and lime mortar.
1 cedar pole, creosote-brushed.
3 fir poles, creosote-tanked.

Soil—
12 poles, sand and gravel, or loam.
15 poles, rock and adobe.
6 poles, adobe.

Life—
21 poles, 10 years (plus) estimated.

Four poles, 50-ft. red cedar with 8-in., 8-in., 7-in. and 6-in. tops respectively; lime-mortar treated; set in soil composed of sand, gravel and loam; infested with termites and rot; in very poor condition and should be changed at once.

Five poles, 50-ft. red cedar with 9-in., 8-in., 8-in., 8-in., and 7-in. tops respectively; lime-mortar treated; set in soil composed of sand, gravel and loam; three infested with termites and rot and two with dry rot; remaining life estimated at six or seven years.

One pole, 50-ft. red cedar with 8-in. top; creosote-tanked and lime-mortar treated; set in soil composed of sand, gravel and loam; infested with termites and rot; remaining life estimated at six years.

One pole, 50-ft. red cedar with 7-in. top; creosote-tanked; lime-mortar treated; set in soil composed of sand, gravel and loam; infested with termites and rot; remaining life estimated at two years.

One pole, 60-ft. red cedar with 8-in. top; brush-treated with creosote; set in adobe and rock; infested with tremites and rot; remaining life estimated at seven years.

December 14, 1925. 38 poles set in 1918 and located north of Oceanside and south of Las Flores.

Height—
35 poles, 50 ft.
2 poles, 55 ft.
1 pole, 65 ft.

Top Size—
11 poles, 7 in.
20 poles, 8 in.
2 poles, 10 in.

Variety—
24 poles, Douglas fir.
14 poles, red cedar.

Treatment—
23 fir poles, creosote-tanked.
1 fir pole, creosote-brushed.
13 cedar poles, creosote-tanked.
1 cedar pole, not treated.

TABLE II.—Data on life of western Red Cedar poles treated with creolineum applied on butt with brush, or cold dipped.—Southern Sierras Power Company.

Name and Location of Line	Year Built	Total No. of poles	Normal size	Stubbed prior to 1920	Stubbed between 1920-24	Stubbed 1924 No.	Stubbed 1925 No.	Replaced with new poles prior to 1925
Riverside-Glen Avon-Corona	1912	691	35′x8″	74	34	49	5	20
Line, Iowa & Columbia St., to Corona Sub.								
Bloomington Line from S. B. Steam Plant to Declez, pole B-310	1912 & 1913	312	35′x40′x7″	14	20	22	9	1
Riverside-Perris-Elsinore Line from 8th St. Riverside to Elsinore sub.	1913	958	35′x8″	15	41	60	14	1
Perris-San Jacinto-Hemet Line from Lakeview B-206 to Hemet B-640	1912	439	35′x8″	11	15	18	8	1
Redlands Line & Imp. Valley Line from Steam Plant to Redlands sub.	1913	351	50′x8″ and 40′x8″	0	20	8	3	0
Arlington Line from Glen Avon sub. to Arlington	1913	170	40′x8″	8	6	4	1	0
Lytle Creek Line from S. B. Steam Plant to B-146	1913	148	40′x8″	5	6	11	5	1
Wineville Line from Pole B-499 of Corona Line to Chas. Stern & Co. sub.	1912	81	40′x8″	13	8	10	1	0
Totals	..	3150	..	140	150	182	46	24

Total poles stubbed or replaced to date 542 or 17.2 per cent.

TABLE III.—Data on life of Western Red Cedar poles creosote "B" open-tank treatment.—Southern Sierras Power Company.

Name and Location of Line	Year Built	Total No. of poles	Normal size	Stubbed prior to 1920	Stubbed between 1920-24	Stubbed 1924 No.	Stubbed 1925 No.	Replaced with new poles prior to 1925
Corona-Elsinore Line (Temescal Canyon) from B-1033 to B-1333	1917	309	40′x8″	0	3	2	0	16 (probably fire)
Liberty Ranch Line, Perris Valley from Elsinore Line B-903 to Liberty Ranch	1917	130	40′x8″	0	0	0	0	0
Declez-Glen Avon Tie Line from Declez pole B-310 to Glen Avon	1916	110	40′x8″	1	0	2	0	1
Muscupiabe Line from Pole B-68 of Cajon Line to Muscupiabe sub.	1918	22	35′x7″	0	0	0	0	0
Totals	..	571	..	1	3	4	0	17

Soil—
9 poles, sandy clay.
2 poles, gravel and loam.
11 poles, loam.
7 poles, heavy loam.
1 pole, sandy loam.
2 poles, adobe.
1 pole, adobe and rock.
5 poles, silt.

Life—
31 poles, 10 years (plus) estimated.

One pole, 55-ft. ft., red cedar with 8-in. top; creosote-tank treated; set in loam; infested with termites; eight years estimated additional life.

One pole, 50-ft., red cedar with 8-in. top; creosote-tank treated; set in adobe; infested with termites; five years estimated additional life.

Three poles, 50-ft., red cedar with 7-in., 8-in. and 9-in. tops; creosote-tank treated; set in silt; infested with termites; five years estimated additional life.

One pole, 50-ft., red cedar with 7-in. top; not treated; set in loam; infested with termites; four years estimated additional life.

One pole, 50-ft., Douglas fir with 8-in. top, creosote-brush treated; set in sandy clay; infested with termites and rotting; must be replaced at once.

Southern Sierras Power Company Report

Table II covers a number of 33-kv. distribution pole lines on which a fairly complete record of pole stubbing and replacement has been kept. Part of the lines in this list, as may be noted, were erected during the years 1912 and 1913. These poles practically all were given a superficial brush treatment, using special creosote preservative. Most of these were treated in our yards or in the field. Some of the poles were received from the supplier already treated and records do not show whether preservative was applied by brush or by dipping. At any rate records show that we did not buy any poles prior to February, 1914, that were treated by the open-tank method. After the above date, however, all of our pole purchases have specified the open tank "B" treatment and all poles have been western red cedar, partly from Oregon and partly from Idaho, except two carloads of Douglas fir poles purchased in 1924, that had been treated by the reuping process. None of these, however, is included in the tabulation.

In general it might be said that our belief is that cold special or other creosote preservatives superficially applied by brush or cold dipping are of little or no value as a pole preservative and probably not worth the initial expense. We do not believe that sufficient time has elapsed to draw definite conclusions relative to the open-tank treatment, but our belief is and the tabulation will indicate that this treatment does have a decidedly beneficial effect and probably is worth the additional cost.

With respect to the full-length treated Douglas fir poles it is, of course, too early to draw any conclusions relative to the protective value of the treatment. Our obesrvation so far has been that the treatment practically eliminated checking and splitting of the poles and we believe also the twisting of poles that has been observed in untreated poles of several varieties of fir and pine. If the treatment permanently prevents checking and splitting there is every reason to believe that it will be an effective preventative of termite damage although this remains to be proved by several years of use.

Experience of The Southern Sierras Power Company with full-length treatment, in common with that of other companies who purchased poles at about the same time was unfortunate with respect to the large amount of free creosote which was left on the surface of the pole. This made them very objectionable to the men handling them and until this difficulty can be overcome The Southern Sierras Power Company is not disposed to purchase more poles treated in this manner.

Referring again to the tabulation the column showing the number of poles stubbed in 1920 is based upon a general inventory of distribution lines made at that time. It has been our practice during the past two or three years to examine poles on our 33-kv. lines annually and to stub those which showed signs of weakness. The determination of the method or the necessity for stubbing is made partly by excavating around the base of the pole to examine the condition of the surface and also by testing the strength of the pole by means of pike poles on either side.

Los Angeles Bureau of Power and Light Report

The North Garvanza 33-kv. line was one of the first lines installed by the Bureau of Power and Light during the early part of 1916. These poles all were treated with creosote by the open-tank method. An inspection made during December, 1925, of about a mile of line failed to show any sign of decay. These poles all were in good shape, having no checks or cracks near the ground line. The dirt was taken away from the butt about a foot below the surface, the poles sounding solid and no decay showing.

A recent inspection made of a mile of poles installed in 1917 in the vicinity of Figueroa and Florence showed the same condition except that four of the poles had checks in them which extended below the ground line. In the vicinity of these checks the poles showed evidence of decay.

The Bureau of Power & Light never has installed anything but butt-treated poles. However, as the first poles were installed during 1916, we are unable to give data which would tend to show the life of poles beyond that time.

Southern California Edison Company Report

A definite inspection was made of four particular lines, first a section of the old Newmark-Pasadena 15-kv. line. In the particular section inspected there are 24 50-ft. red cedar poles. These poles were set untreated and unpainted in 1912. The soil in this location is a gravelly clay, well drained. These poles all were exceptionally large at the butt and though the sapwood is decayed and the heartwood showed signs of decay in a number of locations, this line would probably serve several more years due to the fact that the poles were so large that sufficient live wood was left intact. Nearly all of these poles show signs of termites.

Second, a portion of the old Huntington Beach line. This line was built in 1914 of untreated red cedar poles. This particular section inspected consisted of 55 40-ft. poles set in sandy loam, part of the territory being alkali. All of the poles show bad signs of decay and about 40 per cent of them need to be replaced or stubbed at the present time. Also all of the poles are badly infested with termites.

Third, a 10-kv. line out of Long Beach on Cherry Street. These poles are red cedar, untreated and unpainted, set in 1908. This particular group inspected consisted of 85 40-ft. poles. The soil is black adobe. This whole line is in very poor condition, all the poles being badly decayed. Sixty per cent of them are stubbed and some of the poles have two stubs, the first one having decayed. This line is being replaced at the present time by new poles.

Fourth, a section of distribution line on Center Street, just east of the town of Cypress. This particular section of line consisted of 25 red cedar 45-ft. poles butt-treated by the open-tank method. These poles were set in 1916 in sandy loam soil. All of the butts are in very good condition showing no signs of decay. Every pole is infested badly with termites down to the creosote line on the pole, which is approximately 2 ft. above the ground. These poles are in such condition that they probably will have to be replaced within four or five years due to the bad condition of the part above ground. This same condition, of treated poles with the butt in perfect condition and the unprotected top badly eaten by ants, is a common occurrence in many different sections.

An experiment which has been carried out is the cutting off of the decayed portion of an old pole and resetting the pole untreated, as a shorter one for service in certain locations. Examination showed that these poles at the end of approximately 3 years were in as bad a condition as new poles which had been in service 10 or 12 years. In Ventura County we took down many miles of pole lines that had been set for approximately 14 years. The butts were in very bad condition, over half of the poles being stubbed. These were 45 and 50-ft. poles and were cut back and treated with cold creosote in open

tanks, giving a 48-hr. immersion. These poles then were reset for a low-voltage distribution and have been in service for approximately five years. Recent inspection showed that the butts are in very satisfactory condition, but the tops of the poles being approximately 20 years old are causing considerable trouble due to splitting. This development probably will cause early replacement.

Los Angeles Gas & Electric Corporation Report

TABLE IV.—Western Red Cedar poles. Tops of all poles painted, butts treated as shown. All poles located in Los Angeles.—Los Angeles Gas & Electric Corporation

Overall Length of pole (ft.)	App. Dia. of top (in.)	Date Set	Soil Conditions	Condition of pole Jan. 1926	Estimated additional Life	Treatment
60	8	1914	Dry Sandy	2 in. dry rot	2 yrs.	None
60	8	1914	Dry Sandy	2 in. dry rot	2 yrs.	None
60	8	1914	Dry Sandy	2 in. dry rot	2 yrs.	None
60	8	1914	Dry Sandy	1 in. dry rot	3 yrs.	None
60	7	1914	Dry Sandy	1 in. dry rot	3 yrs.	None
60	7	1914	Dry Sandy	3 in. dry rot	1 yr.	None
60	7	1914	Dry Sandy	3 in. dry rot (ants at work)	1 yr.	None
60	6	1914	Dry	Good	6 yrs.	None
60	6	1914	Dry	1 in. dry rot (2 in. dry rot) (ants at work)	3 yrs. 1 yr.	None
60	8	1914	Dry	3 in. dry rot	1 yr.	None
60	8	1914	Dry	Rotted off	None	None
60	8	1914	Dry	2 in. dry rot	2 yrs.	None
65	8	1914	Dry	Good	6 yrs.	Charred butt
65	8	1914	Dry	Good	6 yrs.	Charred butt
65	8	1914	Dry	Good	6 yrs.	Charred butt
65	8	1914	Dry	Good	6 yrs.	Charred butt
65	8	1914	Dry	Good	6 yrs.	Brush-treated butt
65	8	1914	Dry	Good	6 yrs.	Brush-treated butt
65	8	1914	Dry	Good	6 yrs.	Charred butt
65	8	1914	Dry	Good	6 yrs.	Charred butt
65	8	1914	Dry	Good	6 yrs.	Brush-treated
65	8	1914	Dry	Good	6 yrs.	Brush-treated
65	8	1914	Dry	Good	6 yrs.	Charred butt
65	8	1914	Dry	Good	6 yrs.	Charred butt
65	8	1914	Dry	Good	6 yrs.	Charred butt
65	8	1914	Dry	Good	6 yrs.	Charred butt
65	8	1914	Dry	3 in. dry rot	1 yr.	None
65	8	1914	Dry	2 in. dry rot	2 yrs.	None
65	8	1914	Dry	1 in. dry rot	3 yrs.	None
65	8	1914	Dry	3 in. dry rot	1 yr.	None
65	8	1914	Wet Sandy	3 in. dry rot	1 yr.	None
65	8	1914	Dry Sandy	Worms and ants, rotted off	None	None
65	10	1914	Wet Sandy	1 in. dry rot	3 yrs.	None
65	8	1917	Dry adobe	Good	10 yrs.	Open-tank
65	6	1917	Decomposed granite, dry	3 in. dry rot	2 yrs.	Creosote
65	6	1917	Dry yellow clay	Good	10 yrs.	Creosote
65	6	1917	Dry yellow clay	Good	10 yrs.	Creosote
65	7	1917	Wet adobe	Good	10 yrs.	Creosote
65	6	1917	Dry yellow clay	Good	10 yrs.	Creosote
65	6	1917	Dry sandy	Good	10 yrs.	Creosote
65	6	1917	Wet adobe	Good	10 yrs.	Creosote
65	8	1917	Dry yellow clay	Good	10 yrs.	Creosote
65	8	1917	Dry adobe	Good	10 yrs.	Creosote
65	6	1917	Dry yellow clay	Good	10 yrs.	Creosote
65	8	1917	Dry yellow clay	Good	10 yrs.	Creosote
65	7	1917	Dry yellow clay	Good	10 yrs.	Creosote
65	8	1917	Wet adobe clay	Good	10 yrs.	Creosote
65	6	1917	Decomposed granite, wet	Good	10 yrs.	Creosote
65	6	1917	Decomposed granite, dry	Good	10 yrs.	Creosote
65	6	1917	Dry yellow clay	Good	10 yrs.	Creosote
65	7	1917	Dry yellow clay	Good	10 yrs.	Creosote
65	8	1917	Dry clay adobe	Good	10 yrs.	Creosote
70	6	1917	Wet yellow clay	Good	10 yrs.	Creosote
75	6	1917	Wet adobe	Good	10 yrs.	Creosote
75	8	1917	Wet adobe	Good	10 yrs.	Creosote
70	6	1917	Wet adobe	Good	10 yrs.	Creosote
65	8	1917	Wet yellow clay	Good	10 yrs.	Creosote
65	8	1917	Wet adobe	Good	10 yrs.	Creosote
65	6	1917	Dry adobe	Good	10 yrs.	Creosote
65	6	1917	Dry adobe	Good	10 yrs.	Creosote
65	6	1917	Dry adobe	Good	10 yrs.	Creosote
70	6	1917	Dry adobe	Good	10 yrs.	Creosote
70	6	1917	Dry adobe	Good	10 yrs.	Creosote
75	6	1917	Dry adobe	Good	10 yrs.	Creosote
75	6	1917	Dry adobe	Good	10 yrs.	Creosote
75	8	1917	Dry adobe	Good	10 yrs.	Creosote
80	6	1917	Dry adobe	Good	10 yrs.	Creosote
90	6	1917	Dry adobe	Good	10 yrs.	Creosote

San Joaquin Light & Power Corporation Report

During 1911 and 1912 we built more than 200 miles of transmission line using butt-creosoted red cedar poles 50 ft. in length. To date these poles are in good condition and it never has been necessary to replace any of them because of deterioration either above or below the ground. These poles are set in all kinds of soil including black and white alkali. It is believed that they will last 15 or 20 years longer.

During the war when creosote was hard to obtain we set approximately 22,000 Port Orford poles untreated. A great number of these poles had to be stubbed within three or four years, and the stubbing has gone on continually up to the present time. We have stubbed at least 50 or 60 per cent of these poles to date and it is only a matter of three or four years more until the entire 22,000 will be stubbed. The biggest part of the deterioration in the Port Orford poles, in some districts, has been caused by ants. However, if the Port Orford poles were creosoted they would in all probability last 20 years. At the present time a line built of Port Orford creosoted poles in the Spring of 1917 is being replaced and the poles show practically no sign of deterioration. In fact they are in such good shape that we intend using them on a distribution line without retreating.

Pacific Gas and Electric Company Report
(West-Side Division)

The following report covers poles on the Pacific Gas and Electric Company's lines in the Sacramento Valley, north of Sacramento to the north limits of the system in Shasta County. As it was not practical to inspect all the poles in any certain line, from 10 to 20 poles in various localities in a line were inspected carefully and their condition was taken as representing the average for the whole line for the untreated poles. Inspections also were made on lines of butt-treated poles, but on account of the fact that the first treated poles were set in this locality in 1921 very little valuable information is obtainable at the present time. Some data also are given on the termite and the full-length treated fir poles.

Untreated Poles

Data as tabulated (tables not published) on the various lines indicate that the average life of untreated poles in this northern section of California is about 20 years. Several lines or sections of lines still are giving service after 25 years. Other points brought out by this study and determined by actual recent inspection of different size poles in various types of soils are as follows:

1. Eastern-slope red cedar lasts longer than western-slope red cedar poles. In most cases, in any line where there are both kinds of poles, the western-slope pole will need stubbing before the eastern slope pole.

2. Poles with large butts of course last longest.

3. Poles set in lava last the greatest number of years while those set in adobe rot the quickest.

4. Small poles, 25 and 30 ft. long and of small diameter at top and bottom, rot out after a few years and tops crack and check.

5. Woodpeckers attack poles only where the poles are near oak trees. The woodpeckers peck holes in poles in which to store acorns and not for anything they find in the poles.

6. Poles set in black adobe soil were found to be completely rotted off 2 ft. up from the bottom. These were new untreated poles set in 1921.

7. A number of poles in one line 24 years old were found to be only a shell under ground. Upon inspection of several poles, 2 in. of solid wood was found on the circumference of the butts of the poles, with the center rotted out from the bottom to a point 6 in. above the ground. This condition existed both in adobe and in gravel soil.

8. Redwood poles seem to give very good service, but will cost considerably more than cedar in the longer poles being used today.

Treated Poles

The first open-tank, creosote-penetrated, butt-treated poles were set in this locality in 1921. Inspections were made recently of a number of butt-treated poles set at that time and the butts were found to be in excellent condition, almost as good as the day the poles were set except for two poles upon which the termites had started to work. These poles will be covered in a later paragraph.

As treated poles have been in use only a few years there is no more that can be said about them at this time. Most all treated poles set are northern red cedar, 35 ft. and over in length and with top diameters from 8 in. and up.

Termites

The only termites found in this locality were found in poles in a distribution line south of Red Bluff, (not included in preceding list). This line was built in 1921 and both butt-treated and untreated poles were set. Termites were found in some of the untreated poles just below the ground line but they have not penetrated below the sap. Termites were found in two butt-treated poles just below the ground line. These are 8-in. top, 35-ft. poles with a butt diameter of approximately 14 in. The penetration of the creosote on these two poles is not very deep and the termites are working beneath the creosote. On one of the poles they are leaving a creosoted shell around the poles and have eaten the poles away under this shell for about ¼ in. The butts of these two poles appear to be in sound condition where the termite is not working. Poles attacked by termites, both untreated and treated, are set in black adobe soil.

Full-Length Treated Poles

Recently 56 full-length treated 50-ft. Douglas fir poles were set in a 60-kv. line north of Corning in the West-Side division. These poles were in the pole yard a year and a half before they were used. They were roofed, gained and bored for steps before treatment. When they were set it was found that some of the gains had to be squared up on account of the poles having twisted in seasoning after treatment. In cutting into the gains, it was not necessary to penetrate below the creosote. The lineman did not experience any trouble from creosote burns while working on these poles as the poles were set in December.

Pacific Gas and Electric Company Report Sacramento Division

Sacramento County

A total of 23 poles were examined, 18 more or less infested with termites. Four of 18 showed termites in tops of poles. One pole showed evidence but no live termites. Most of the poles were cedar and set from 2 to 30 years. Redwood poles also were found to be infested; some redwood stubs set in 1924 were filled with termites.

Both species of termite were found, the small ones working principally in the sap wood below or just above the ground and the large termite at or below the ground line and in both the sap and heart wood. Butt-treated poles set five years ago showed no signs of termites.

Yolo County

Of 16 poles examined eight showed termites and one of the eight was infested in the sap wood at the top of the pole.

Solano County

The several locations inspected showed no indications of termite.

Mr. Maynard, superintendent of the San Jose division, reports that of 27 poles examined 25 were infested, one for its entire length and one for about 30 ft. The remainder were affected principally at the ground line and for approximately 2 ft. below and above ground.

The line reported upon extends from near San Jose to Salinas and consists of 60-ft. cedar and fir poles set in 1912. The soil generally is sandy loam.

Cedar stubs set in 1922 also were found to be infested.

From information gained so far, it appears that:

1. Termite is on the increase.
2. Soil conditions have but little to do with infestation.
3. Most any kind of wood is subject to their attack, although the softer woods are preferred.

Causes of Pole Deterioration

It may be noted from the remarks in the foregoing that the more usual causes of pole deterioration are natural rot and termites (white ants). Of these two, the termites seem to be the more serious. Poles and crossarms which otherwise would be sound are found to be entirely riddled by these pests. See Fig. 1.

A general description of the termites is given in the 1922 and 1923 reports of the N.E.L.A. overhead systems committee. Briefly reviewing what is given there it should be stated that there are two species which attack poles.

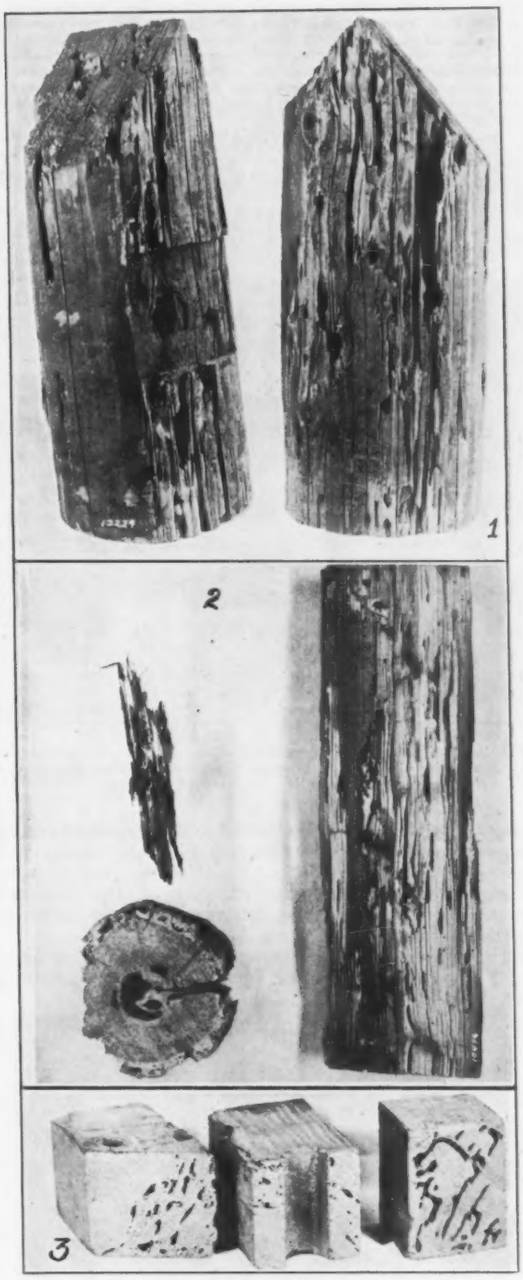

Fig. 1. Samples of termite ravages. 1—exterior of cedar pole. 2—sections through cedar pole. 3—fir crossarms.

The species Reticulitermes Hesperus Banks lives in the ground and enters the poles through subterranean passage and requires a certain amount of moisture in order to live. For this reason, even though it may work up the pole for a distance of several feet, it always will keep its runways open so as to return to the ground for moisture. In some respects the work of this species is more dangerous than others because of the fact that it is more vital to retain the strength of the pole near the ground line than at other points higher up. It is reasonable to expect that a good butt-treatment of hot creosote will protect the butts of poles against this species of termite for a number of years, until the creosote is leached out or checks open up in the pole, permitting termites to enter the pole without having to eat their way through the creosoted areas.

The other species of termite which is prevalent in southern California is the Kalotermes minor Hagen. See Fig. 2. This specie enters the poles from the air at times of swarming, either at the top or through lateral cracks or checks. It is able to live its life without having to go to the ground for moisture, maintaining itself almost indefinitely in the dryest wood. The protection of poles against this species of termite is a serious question, as it cannot be kept out of the pole by merely creosoting the butt.

The winged adults swarm at certain seasons of the year, the males and females pairing off and lighting on the poles where they immediately snap off their wings, enter the cracks and from these retreats readily bore their entrance tunnels into the sap or heartwood as the case may be. There they soon establish new colonies. Once these insects have become well settled they will continue to multiply and to tunnel until they have honeycombed the entire pole.

Reports of the committee members show that the termites are more or less active in all parts of the state, probably being most active in the southern portion.

Other causes of pole destruction which are encountered occasionally are, woodpeckers and carpenter

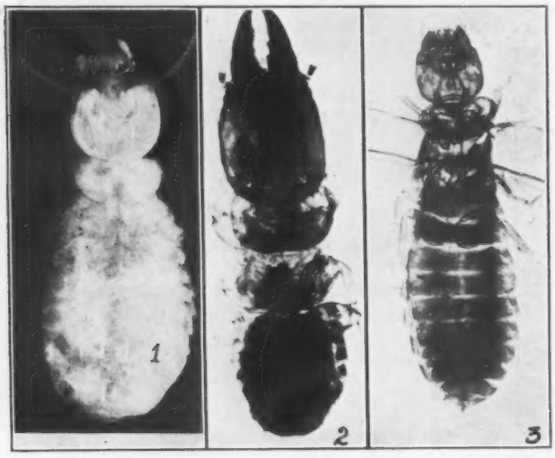

Fig. 2. Miscroscopic reproductions of the termite, magnified about 14 diameters. 1—worker termite, Kalotermes. 2—soldier termite, Kilotermes. 3—sexed termite, Kalotermes, at time of swarming.

bees. The woodpeckers seem to be especially active where pole lines pass through districts where there are oak trees. Fig. 3 shows the manner in which these birds will stud the exterior of the pole with acorns and excavate the interior for their nests and further storage of acorns.

The attack of the carpenter bee (Xylocopa) is shown by Fig. 4. The carpenter bee resembles in appearance

Fig. 3. Examples of woodpecker damage

the bumble bee, being about the same size, but without yellow markings. In the mature state it is black.

These bees eat horizontally into the pole until they get well under the surface and then extend their excavations longitudinally. The size of the excavations varies from ⅜ to ¾ in. in diameter and 6 in. in length. The carpenter bees seem to attack only rather soft wood and the damage which they have done has not been serious.

Conclusions and Recommendations

For the purpose of this report, it will be considered that the life of a pole has ended when it is necessary to spend money to continue it in service.

From the reports given above it appears that the life of untreated western red cedar poles in most locations has been from 10 to 15 years and for butt-treated poles from 15 to 20 years. No doubt in districts where the termite attack is more severe, if the rule was followed of replacing the pole when its safety factor has been reduced to two-thirds of the minimum required for its respective grade of construction, it would be found that the lower figure in each case is about the average life. The conclusion, therefore, is quite obvious. In locations infested with termites a full-length treated pole should be used.

Western red cedar is becoming more scarce each year and gradually increasing in price. There are two species of wood, however, which can be had in abundance in pole sizes, the southern pine and Douglas fir. Both of these timbers, on account of their thick sap-wood, take creosote pressure-treatment well. Fig. 5 shows representative increment borings taken from these two kinds of poles which had been given the 8-lb. empty-cell pressure treatment. In general the

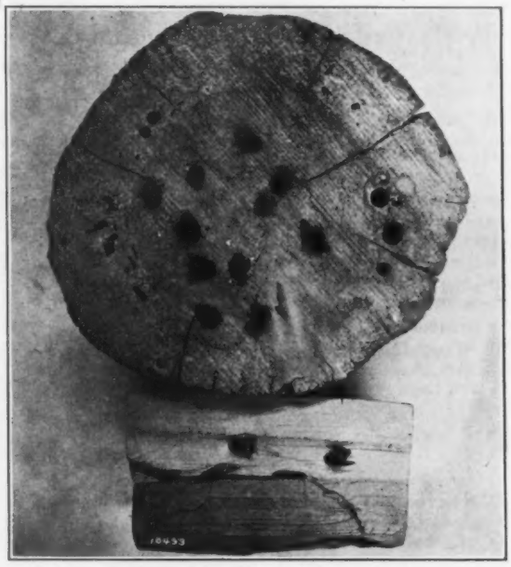

Fig. 4. Cross-section of cedar pole attacked by both termites and carpenter bees. Bees excavated from their (round) holes may be noted lying on the surface of the wood.

southern pine has a thicker sap-wood than Douglas fir and takes a deeper penetration. The increment borer for making these tests is shown in Fig. 5. The holes so made always should be closed with creosoted plugs.

The report of the Forest Products Laboratory gives the strength of southern pine as from 7,500 to 8,700 lb. per sq.in., and Douglas fir 7,800 lb. as compared to western red cedar 5,200 lb. Their weight is somewhat greater than cedar, but due to the greater strength the usual practice is to use poles of 1-in. less diameter than of cedar.

Full-length pressure-treated southern pine has a life record of some 28 years to date in the southern states and these same poles are reported to be good for many more years. Douglas fir has not been used heretofore for poles to any great extent, but it has made a good record in other strucutral uses when pressure treated. The report of the San Diego company indicates that the butt-treated fir is to be preferred to butt-treated cedar.

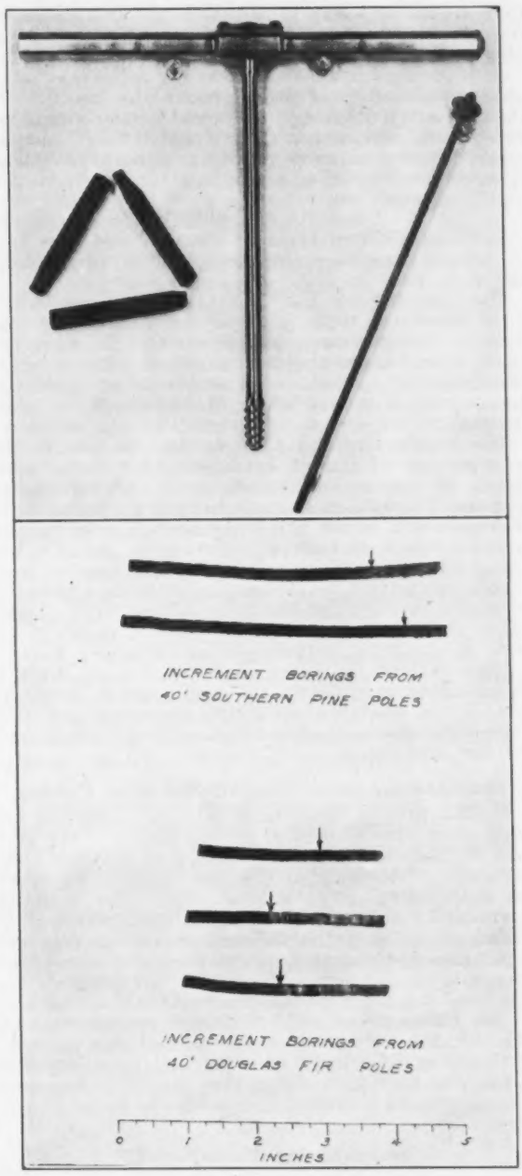

Fig. 5. Increment borings (below) and the increment borer (above). Samples of creosoted plugs for closing test holes may be noted (above).

The Southern Pacific Company has installed a number of full-length treated Douglas fir poles. At the present time it has installed full-length creosoted Douglas fir poles in its overhead tramway at Oakland Sixteenth Street station. These poles were treated in 1909 by the full-cell process and they apparently are in sound condition after 15 years of service, nor do they show any checks or twisting.

It also is reported that creosoted fir piling removed from the Southern Pacific Company's Santa Monica wharf after 27 years of service and from the Oakland dock "A" after 29 years of service still were in such good condition that they were reused at other locations.

It seems that the termites are particularly attracted by cedar. Possibly because it is a soft wood or maybe because of its flavor. Another theory is that due to the frequent checking in a cedar pole the termite has ready access. At times of swarming they are seeking shelter from the birds which pursue them. Whatever the reason it is quite usual to find a cedar pole completely riddled by termites and the fir crossarm untouched. Or if the arm is attacked the entrance is made from the pole at the gain.

The first cost of full-length, 8-lb. pressure-treated Douglas fir shipped from Oregon or Washington by boat is about the same as cedar butt-treated and painted. Southern pine, due to the freight charge, is somewhat higher than cedar.

When making a comparison of different kinds of poles and treatments the annual charges should be considered rather than the first costs. In determining these annual charges an assumption first must be made of the expected life of each kind of pole and thus the annual depreciation obtained. To this should be added the interest charge. Plotting the sum of these charges for the various kinds of poles against length delivered at a given location will be a valuable aid in making a choice of poles to use.

Our recommendation is that not only full-length treated poles be used but also the crossarms, wooden pins, and any other wooden attachments on poles be treated with creosote.

References

Mechanical Properties of Woods Grown in the United States, U.S. Department of Agriculture, Bulletin No. 556.

A Revision of the Nearctic Termite by Nathan Banks with Notes on Biology and Geographic Distribution by Thos. E. Snyder, Smithsonian Institution Bulletin No. 108.

N.E.L.A. overhead systems committee reports 1922 and 1923.

Transformer Standardization*

Four subdivisions of this subject were considered by the subcommittee, as previously recommended. At least two of the subdivisions undoubtedly are of considerable value at this time and should receive the careful attention of the member companies.

Electrical Characteristics to Permit Banking for Parallel and Polyphase Operation

By H. S. LANE

It is not the aim of this report to make a technical exposition of the subject, but rather to discuss briefly its practical aspect by reference to cases experienced in practice.

Obviously the division of load between two transformers banked in parallel and supplying a common load will depend upon the related factors of impedance and regulation. The regulation of a transformer depends not only upon its total internal impedance but upon the ratio of its reactance and resistance. Thus at a given load current the apparent drop in the transformer will vary with the power factor of the load, being a maximum when that is equal to the "power factor" of the transformer impedance. Therefore the statement that two transformers in parallel will divide a load inversely as their impedances is correct only if the impedances are considered vectorially.

The relation of resistance, reactance and total impedance in the design of the several lines of power and distribution transformers is governed by the emphasis placed upon all-day vs. full-load efficiency and by the desire, particularly in power transformers, to limit short-circuit currents. The present tendency is toward higher impedance-ratios. Power transformers formerly 3 to 4 per cent now run usually 6 to 8 per cent. Distribution transformers formerly 1 to 3 per cent, now 2½ to 5 per cent. In a representative line of distribution transformers the impedance ratio increases slightly with the kva. rating. In the smaller sizes the ratio of resistance to reactance increases, resulting in better regulation at low power-factors.

If the parallel transformers are not at the same location then obviously the impedances of the circuits, particularly the secondaries connecting them, are involved in the problem as well as the distribution of the load with respect thereto. Two extremes in this respect met in practice are illustrated in the two cases following.

* Report of Joint Subcommittee of apparatus committee and overhead systems committee. H. H. Minor, chairman. K. B. Ayres, A. W. Copley, J. H. Cunningham, H. S. Lane, H. L. Sampson.

In one case a 100-kva. single-phase subway transformer was installed in manhole A, supplying 3-wire secondary cable extending to manhole B at the next corner. The aggregate service load at A was about 100 kva., at B about 25 kva. A 25-kva. transformer was installed at B to relieve transformer A. Transformer B got excessively hot and a test showed that it was carrying about 75 kva., while the larger one at A was carrying only about 50 kva. Investigation showed that the impedance of the older-type 25-kva. transformer was less than that of the 100-kva. transformer, while the drop in the secondary was negligible; hence the effect noted. This and other similar cases were corrected by connecting small reactances of the proper value in the secondaries, mounted inside the transformer case.

The opposite condition is presented by the connection of transformers in parallel to overhead secondaries where the line impedance may be large relative to the transformer impedances. In one such case of two similar transformers the load was so unequally distributed along the line that one transformer was seriously overloaded. This as well as other similar cases was corrected by judiciously adjusting the number, size, and spacing of the transformers as well as secondary wire-size, to obtain proper distribution of loads and line-drops.

This difficulty does not frequently enter in respect to power transformers since such transformers selected for parallel operation are nearly always exactly similar. No instances of such cases of difficulty are at hand.

All of the above, of course, is based upon the presumption that the transformers involved in the parallel are of equal voltage ratio.

The division of load, in particular unbalanced load, between the transformers of a 3-phase bank with delta secondaries presents two distinct cases, depending upon whether the primaries are connected star, ungrounded, or delta.

In the case of ungrounded star primary connections, while the impedance drop in the transformers affects the result in a slight degree, practically the criterion which determines the division of current is the condition that the sum of currents at the primary neutral equals zero.

With primary connected delta the condition for solution is that the sum of the impedance drops in the transformers shall equal zero. In this case the single-phase load divides in the two paths in inverse ratio of their impedances. With single and 3-phase loads of the same power factor and similar transformers of equal impedance ratios, transformers selected for the three phases in accordance with their respective kva. connected load properly will divide the combined load.

Both of these cases can be proved easily by vector diagrams, using the proper phase relations and considering the power factor of each load. The study will be found very interesting and can be substantiated readily in actual installations.

It is believed that this discussion may be of value in the consideration of these conditions, which are met with every day in the field. It is probable that not enough thought has been given the subject, in many cases resulting in damaged or destroyed transformers due to the unequal division of load in 3-phase banks.

Improvement in Fuse Protective Devices

By M. O. BOLSER

Before any constructive work could be accomplished it was necessary to find out the type of fuse used by the different companies of the P.C.E.A. We therefore sent out a questionnaire to the different companies.

Without exception porcelain-plug cutouts are used for the smaller sizes of transformers on 2.3 kv. Several different makes of expulsion-type primary cutouts are used for capacities of 25 to 100 amp. Oil-type cutouts or oil switches usually are used above 100 amp.

Comments from the different utilities seem to indicate that the porcelain-plug cutouts, even for the smaller-sized transformers, were liable to be destroyed under short circuits. They are used only because they are cheap. Any substitute in the smaller capacities would cost from 5 to 10 times the cost of the plug cutouts.

One company uses expulsion-type cutouts on all of the smaller sizes of transformers due to the fact that the line voltage is 4.6 kv. and porcelain-plug cutouts would not stand the voltage. Each company seems satisfied with the particular make of expulsion-type cutouts that they are using.

Tests on Cutouts

Tests on different types of cutouts have been made by several companies, but under different conditions and it is hard to draw any conclusions.

The Los Angeles Gas & Electric Corporation took three standard 100-amp. fuse boxes and connected them in series with a phantom load. In each test, after several hours the C fuse melted while A and B remained O.K. The holder was charred each time due to excessive heat which in each case was about 160 deg. F.

The Pacific Gas and Electric Company made tests on a number of cutouts by subjecting them to short-circuit on the secondary side of a 11/2.4-kv. transformer. These tests and conclusions are to be found in Appendix 2 in the N.E.L.A. overhead systems committee's report of 1923.

The Bureau of Power and Light, Los Angeles, made a number of tests by connecting cutouts to a 3,600-kva. generator through 150 ft. of No. 4 weatherproof wire. All of the cutouts opened the circuit successfully, but some of the fuse containers were damaged.

There is quite a report on fuse-box tests made by an operating company in the east outlined in the report of the electrical apparatus committee for 1925. This gives the maufacturer's name and catalog number for each cutout.

Standardizing Fuses for All Makes of Cutouts

At the present time most of the companies are using plain fuse wire in plug-type cutouts. The criticism of this is that, due to pinching of the fuse under the screw or oxidizing of the fuse metal at the screw, the fuse blows under normal load. The manufacturers make a fuse with terminal lugs, which is interchangeable with the different makes of plug cutouts. Due to the cost it is not used very extensively by operating companies.

It does not seem possible to standardize fuse links for the different kinds of expulsion-type cutouts. The different manufacturers claim advantages in their particular style or type of expulsion cutout and fuse and as the fuse links differ, they could not be standardized without a decided change in the cutouts themselves.

Standardizing Fuse Ratings

The question of fuse rating by the manufacturers has not been given much consideration due to the small amount of information available. The Board of Fire Underwriters states: "Link fuses shall be stamped with 80 per cent of the maximum current which they can carry indefinitely, thus allowing about 25 per cent overload before the fuse melts."

One manufacturer gives the following information regarding his fuse:

> The melting point of our fuse links is around 419 deg. C., maximum. The charring point of the fiber is around 185 deg. C. The boiling point of our fuse metal is about twice the melting point. This is of importance as this is the temperature of the arc. In order to have fuses blow at a reasonable amount of current above their rating it is necessary for the link to become quite hot when the cutout is carrying 100 per cent of the rating of the fuse link. This condition should not be allowed to exist. Cutouts should not normally carry more than about 65 per cent of the rating of the fuse link. There are, in the blowing of a fuse link, two distinct cycles. One is called the heating cycle wherein fuse link heats up to melting point. Then comes the arcing cycle where the principle of the cutout comes into play in interrupting the circuit. Our fuse links normally are designed to melt at a current not exceeding 15 per cent of the rating of the link in a period of time not exceeding 5 min. Our fuse links also are designed to carry 100 per cent current continuously, but when carrying 110 or even 100 per cent the heat of the link has gone up to from 250 to 350 deg. which, you will note, is more than enough to char the holder. This prevents the use of an expulsion-type fuse for overload protection.

It is noteworthy that this manufacturer suggests that a 100-amp. fuse should normally carry not more than 65 amp., which is about full-load current for the

transformer as used by most of the operating companies. It would seem advisable that all of the manufacturers should adopt a rating similar to this; that is, a 100-amp. fuse normally should carry not more than 65 amp., and that the fuse should melt in less than 5 min. at a current not exceeding 150 amp. This is a much wider variation than the Board of Fire Underwriters requires for link fuses, but, owing to the length of the fuse and the amount of heat to be dissipated, it is inadvisable to rate them as close as the fire underwriters rate link fuses.

Terminals and Lead Wires or Connections

By T. W. SNELL

It has been believed for some time that there are various details of the design of transformers to which consideration might be given with a view to bringing about improvements in design which might better fit in with modern tendencies in overhead construction. As a matter of fact there have been very few changes in recent years in certain of the physical details of transformers. This may have been due to a feeling that these details were fixed and construction therefore made to conform to them instead of there being any effort to design a transformer to fit in with contemplated changes in construction methods.

We are assured that if changes in transformer design are desired by the users the manufacturers will be only too glad to make those changes, provided the users will agree that they are necessary. This, of course, is a self-evident fact. As an example, the manufacturers recently have standardized to a large extent on transformer hangers and considerably reduced the number of hangers required for the range of transformer sizes used. This has facilitated joint-pole construction and has simplified handling.

In order that an expression of opinion might be received from member companies on other possible changes in transformer detail a questionnaire has been circulated asking for suggestions on various proposed changes. Responses have been fairly complete and indicate some considerable thought on the questions.

Five details were discussed as follows:

Shell—Most member companies agree that while present dimensions of shells are not objectionable, they strongly favor uniformity in height for a given size of the various manufacturers. This would greatly facilitate installation and simplify construction. One company recommends a maximum height of 4 ft. for sizes to and including 50 kva., this dimension including hangers. It also was agreed that consideration should be given by the manufacturers to the prevention of slopping of oil during transportation. At present this often is extremely objectionable.

Hangers—Previous attention has been given to cutting hangers so that they did not extend below the bottom of the transformer tank. As to the projection of the hanger above the top of the case there was fairly general agreement that this feature of design should remain unchanged. This is due largely to the somewhat different methods of construction employed in various parts of the state. Some few companies believed that raising the transformer even the few inches gained by the change would be justified.

Bushings—All users of transformers agreed that the present location and arrangement of transformer bushings is perfectly satisfactory and fulfills all requirements. Mention was made of the need for so placing bushings as to protect them against breakage and of the desirability of providing a ready means for replacing broken bushings when necessary.

Arrangement of Terminal Blocks—All companies are in favor of a uniform arrangement of leads on terminal boards, but not at the expense of voltage taps, and strongly recommend a stamped connection diagram either on the nameplate or inside the cover. One company favors proving all connections with a voltmeter instead of putting entire dependence on the diagram. This also would locate open connections in the leads.

Leads—Opinion on the use of lugs on secondary leads was equally divided, but those who were in favor of them were especially emphatic in their preference. Therefore it appears desirable to retain lugs providing they are properly and adequately attached to the leads. Most companies believed that leads are preferable to some types of terminal blocks inside or outside of the shell, while other companies thought that some type of terminal blocks would be preferable. All companies favored secondary leads of a length not greater than the transformer case.

A careful consideration of the answers indicates that the consensus of opinion favors making no changes in transformers at the present time except in a few minor details.

Standard Voltage Ratios

By H. H. MINOR

The advisable ratio for transformers is dependent upon the practices of the users of the equipment with respect to distribution voltages and combinations of such voltages. The rating of utilization equipment also has a bearing on such ratios. The following is presented with the idea of evoking discussion of the different ideas presented.

Probably most companies standardize on 115-230 volts as being desirable at the consumer's service. This voltage also is fixed by standard equipment now in use. Therefore it seems logical to base transformer ratios upon that value.

A standard line of transformers for distribution lines long in use by practically all companies is the 2,300/115-230-volt class. It is at present a standard transformer as listed in Rule 9,015 of Electric Power Club standards. This standard transformer does not include primary taps, though transformers with taps can be purchased. Many companies have used and are still using these transformers on 2.3-kv., 3-wire systems.

As load has increased many companies have gone to so-called 4-kv. systems, using the 2.3-kv. transformers connected Y on the primary. This necessitated one of two plans for serving single-phase loads. Either the neutral wire had to be run and the system changed to 4-wire and the 2.3-kv. transformers used connected from line to neutral, or a transformer or voltage rating equivalent to the Y-voltage of the 2.3-kv. transformers used. There is no such transformer included in the Electric Power Club Standards. The primary voltage of such a transformer to deliver the same secondary voltage as the present 2.3-kv. class would be $2.3 \times 1.732 = 3.980$ kv. The larger use of the 4-kv. systems would make it seem advisable to include such a transformer in future standards.

Some use has been made of a 2.3-4.6 kv./115-230-volt transformer, using a 2-coil primary connected in parallel for 2.3-kv. use and in series for use on 4.6-kv. lines. These transformers now are standard. The adoption of this system does not adequately take care of conditions on growing systems when large numbers of 2.3-kv. transformers are in service and load increase has made a higher distribution voltage advisable.

The next higher distribution voltage commonly used is 6.9 kv. A line of transformers for this is included in the Electric Power Club standards, its rating being 6.9-11.95 kv. Y-6.585-6.275-6.960/115-230 volts. These primary taps do not agree with the adopted standard of the Electric Power Club of 5 and 10 per cent voltage variation, but were retained so as to agree with former practice. The logical step for those using these transformers was, as the load density increased, to use them connected Y on 4-wire systems in the same manner as the 2.3-kv. transformers were used on 4-kv. systems. The result was that either the 4-wire primary had to be used or a transformer obtained having a primary voltage approximately equivalent to $6.9 \times 1.732 = 11.95$ kv. The standard transformer available and the one that is used for this purpose is rated at 11.5-10.925-10.35/115-230 volts. It is seen that a discrepancy exists between the ratings of these two classes of transformers. For equal primary voltage the result will be about 4 per cent higher secondary voltage with the 11-kv. class transformers than with the 6.6-kv. class connected Y-delta, when both are operated on full winding.

The rated voltages of these two classes follow:

6,600-Volt Class		11,000-Volt Class	
Primary Volts	Secondary Volts	Primary Volts	Secondary Volts
6,900-11,950 Y	115-230, etc.		
6,585-11,405 Y	115-230, etc.	11,500	115-230, etc.
6,275-10,868 Y	115-230, etc.	10,925	115-230, etc.
5,960-10,322 Y	115-230, etc.	10,350	115-230, etc.

An obvious method of approximately equalizing these two classes of transformers would be to change the 6.6-kv. class by omitting enough turns of the primary winding to make the rating 6.585-11.405 kv. Y-6.275-5.960/115-230, etc. As used at present it is necessary to operate the 6.6-kv. class on that tap and the 11-kv. class on full winding to equalize secondary voltage. Another possibility would be to add enough primary turns to the 11-kv. class to make its rating 11.95-11.5-10.925-10.35/115-230, etc., and to leave the 6.6-kv. class as at present. It has been pointed out that this latter is the more logical because of the great number of 6.6-kv. class transformers in service compared to the 11-kv. class. On the other hand the former has been favored because of present equipment such as motors, converters, etc., being rated at 11 kv. It would seem that the comparatively small number of installations of this kind would rather minimize this objection.

While the above discussion relates to single-phase distribution transformers of 200 kva. and below, it is equally applicable to 3-phase transformers and to power transformers supplying service of 600 volts and below. A change in these classes of transformers also would necessitate a similar change in power transformers supplying distribution voltage.

Data regarding transformer ratios have been collected by a subcommittee of the electrical apparatus committee of the N.E.L.A. under the chairmanship of B. G. Jamieson. A special subcommittee was appointed by Mr. Jamieson to study these data and formulate a recommendation for revised standards to be presented to the apparatus committee. W. P. White of the General Electric Company was made chairman of this special committee and a report was tentatively adopted and distributed to the members of the national apparatus committee. This report is in the form of a table and refers principally to power transformers; sizes above 200 kva. In Mr. White's letter accompanying the table of proposed standards the statement is made that at present less than 50 per cent of the transformers sold in sizes above 200 kva. were standard. This table of proposed standards, in so far as it applies to transformers, is given in Table I.

TABLE I.—Proposed voltage ratings for systems and transformers as per report of N. E. L. A. apparatus committee, sub-committee on transformers and regulators.

Systems (kv.)	Step-up Transformers		Step-down Transformers	
	Pri. kv.	Sec. kv.	Pri. kv.	Sec. kv. 115 volts 230 volts 460 volts 575 volts
2.4	2.3/3.98-Y	2.4/4.15-Y	2.3/3.98-Y	2.4/4.15-Y
4.15	..	..	..	..
6.9	6.6	6.9	6.6	6.9
11.5	11.0	11.5	11.0	11.5
13.8	13.2	13.8	13.2	13.8
23.0	22.0	23.0	22.0	23.0
34.5	33.0	34.5	33.0	34.5
46.0	44.0	46.0	44.0	46.0
66.0	63.0	66.0	63.0	66.0
88.0	84.0	88.0	84.0	88.0
110.0	105.0	110.0	105.0	110.0
132.0	126.0	132.0	126.0	132.0
154.0	147.0	154.0	147.0	154.0
.0	..	220.0	210.0	..

GENERAL NOTE. Guarantees of efficiency, heating, overload, etc. and over-voltage tests of all apparatus should be based on the rated voltage of the apparatus with the exception of step-down transformers, the over-voltage tests on which should be based on rated secondary voltage, and a primary voltage five percent greater than the rated voltage.

SPECIFIC NOTES. The voltage ratings of potential transformers should be the same as the recommended system voltage ratings, their secondaries should be rated approximately 115 volts to permit the employment of the now existing even ratios of transformation.

Transformers should be designed to operate during emergencies at 5 per cent above rated voltage, the overvoltage being obtained by over-excitation and not through the use of taps. They should be equipped with taps as follows:

(a) Step-up transformers should be equipped with the equivalent of two 2½-per cent full-capacity taps in the primary windings to provide additional range for compensating for the voltage regulation of the transformers and to avoid over-excitation of generators.

(b) Step-down transformers should be equipped with the equivalent of four 2½-per cent full-capacity taps in the primary windings to provide additional range for compensating for line voltage drop.

(c) When possible 11.5-kv. systems should be discouraged in favor of 13.2-kv. systems.

Member companies are urged to study carefully this table of proposed standards. It will be found that there are many points not in conformity with Pacific Coast practice that should be made the subject of considerable discussion at future meetings of the Technical Section. There are a number of situations in connection with transformer standards on the Pacific Coast which are not in any way helped by these proposed standards.

The answers to the questionnaires sent out to member companies, P.E.C.A., on this subject have been far from complete and therefore do not express a consensus of opinion. A number of rather unexpected answers were received which indicates a very wide divergence in operating methods by various companies. Briefly, the answers which were received may be summarized as follows: Of the limited number that distribute at 4 kv. only three companies use 4-kv./115-230-volt transformers as furnished by the manufacturers. All others carry the neutral wire throughout and are not concerned with this problem. However, the majority considers it advisable to standardize on transformers having a ratio of 4 kv./115-230 volts.

Of those companies operating 11.5-kv. lines, but three companies use transformers connected star-delta for 3-phase. The number concerned with the problem of reconciling the star transformers now supplied, having a ratio of 6.9 kv./115-230 volts, with delta transformers, having a ratio of 11.5 kv./115-230 volts, therefore is very small. One of these recommends that the 11.5-kv. class should be changed to agree with the 6.9-kv. class. Others recommend that the 6.9-kv. transformers have the ratio changed to agree with the 11.5-kv. class.

No company answering the questionnaire is in favor of the abandonment of the 11.5-kv. system for the 13.2-kv. system as recommended by the N.E.L.A. subcommittee. This, of course, is natural because of the extensive use on the Pacific Coast of the former system.

Because of the few answers received to the questionnaire and the limited amount of discussion and other information available at this time this subcommittee is not as yet in a position to offer any definite recommendations on this subject to the association for presentation to the N.E.L.A. for action.

It is hoped that all member companies will give careful consideration to this report and be prepared to answer a final questionnaire, the answers to which will be submitted as an expression of general opinion of the transformer-using companies in this territory. Additional helpful information will be found on pages 96 and 99 of the 1925 proceedings of the association.

Use of Bare Wire for Distribution Lines*

In considering the use of bare wire on low-voltage distribution lines the committee has endeavored to bring out the arguments against the use of bare wire for such purposes as well as the arguments favoring its use. Investigation has been made among the member companies operating on the Pacific Coast and it has been found that some companies are using bare wire quite extensively on voltages from 220 volts up to and including 4 kv. The subject has been treated under the four following heads:

1. Safety to employees and the general public.
2. Service.
3. Cost.
4. Appearance and adaptability.

Investigation leads to the belief that the main value of weather-proofing on copper wire may be in supplying mechanical separation in cases of accidents.

* **Report of Subcommittee, R. G. Boyles, chairman, E. R. Barber, S. M. Bullis, G. H. Hagar, E. Y. Porter, C. V. Walker.**

The amount of confidence that should be placed in weatherproof wire preventing injury to pedestrians handling or coming in contact with fallen wires depends upon the life of the insulating compound in the insulation. While there is no doubt that some grades of wire installed for a period of one year or less will serve the intended purpose, it is believed that after the insulated wire has been in service for that comparatively short period the protection offered by the insulation is very doubtful. Many cases are on record where insulated wires have fallen to the street and the insulation protected the wire from arcing to the ground, thus leaving the line still energized. Pedestrians have come in contact with these wires and in some cases the insulation has protected them while in other cases it has broken down.

The public generally is much more careful to keep clear of a bare wire if they see one lying in the streeet than they are if the wire is insulated. There are many cases where pedestrians as well as linemen accidentally have come into contact with energized insulated wire and have escaped without injury. The question has been asked: "Would linemen be more careful working on bare circuits than they are when the wire is insulated?" Several fatal accidents occurred in 1925 which have been brought to the committee's attention. One member company had four fatal accidents to linemen working on distribution lines and in each case weatherproof wire had been used in the construction of the line. Some of the member companies of this committee do not think that employees are more careful when working on bare primary than they would be if the wire were insulated. Other members of the committee feel that the linemen will take greater precautions in handling bare wire.

Tests

In order to determine the amount of protection offered by triple-braid weatherproof insulation some tests were made on samples of wire which had been in service for periods of one, two and three years, respectively, in territory adjacent to the beach. In making these tests a standard 30-kv. insulation-testing set was used to step the voltage up from 110 volts to 30 kv. as found necessary. This set consisted of a 3-kva. transformer with a small hand-operated air-cooled induction regulator especially designed for the set. The range of the regulator was 100 per cent boost or buck so that the voltage applied to the transformer could be varied from zero to maximum. A suitable circuit breaker was used between the supply line and the regulator to break the circuit instantly when the insulation on test breaks down. On the high side of the transformer a voltmeter coil to which was connected a portable voltmeter permitted a direct reading of the high-tension test voltage with convenient accuracy and safety. Samples of wire to be tested were placed in a metal-lined tray 4 ft. wide, 5 ft. long and 5 in. deep filled with city hydrant water. One side of the high-tension winding of the transformer was connected to the metal lining of the tray and the other side to the end of the wire to be tested. The results obtained from this test were so startling that other tests were made without water by simply wrapping the sample of wire tested with tinfoil and connecting one side of the high-tension transformer to the tinfoil and the other side to the conductor. The results of this test appear in Table I.

TABLE I.—Break Down Voltage Test Triple-Braid Weather-Proof Wire.

Wire Size	Age in Years	Condition of wire	Break-down Voltage Wire Immersed in water	Wire wrappedwith Tin Foil
No. 2	1	Good	3,400	4,000
No. 2	2	Outside braid showing white threads, other braids black color	0	1,000
No. 2	3	All braids showing white threads	0	650
No. 4	1	All braids black color	0	700
No. 4	2	Outside braid showing white threads, other braids black color	0	1,000
No. 4	3	All braids showing white threads	0	1,000
No. 6	1	All braids black color	2,000	2,900
No. 6	2	Outside braid showing white threads, other braids slightly discolored	0	0
No. 6	3	All braids black	0	0
No. 2	New	O. K.	2,700	3,000
No. 4	New	O. K.	3,500	3,500
No. 6	New	O. K.	2,200	2,800

Note: The braids designated a black color, except No. 2 and No. 6 size, age 1 year, had only a very thin coating of insulating compound.

Service

It finally was agreed by the committee that weatherproof wire should be used in urban or congested districts even though the protection offered by the insulation is questionable. In many cases one interruption to service in a heavily loaded district would offset the saving made by the use of bare wire and unquestionably the insulation in cases of this kind saves many interruptions. In rural territory the use of bare wire for 110, 220, 440, 2,300, 4,000 or 4,400 volts is used quited generally. Bare wire is not recommended for service wire in any case. When necessary to reinforce or change conductors with the circuits energized it is much more difficult to accomplish this work without interruption to service when bare wire is used, as the weatherproof wire often prevents burndown when conductors swing together while stringing in. From the information received by the committee it would appear that service conditions were more favorable where insulated wire is used rather than the bare.

Cost

There are a number of items entering into the cost of constructing and maintaining weatherproof lines which do not appear when building lines where bare wire is used. Of course the greatest single item would be the saving in insulation. In using bare wire the span can be increased in length thereby effecting a saving in poles, crossarms and hardware; also the labor saving in erecting the supporting elements of the line as well as the labor saving on handling the conductors is appreciable. One company estimates a saving of 8 per cent in addition to the saving made in the use of bare-wire conductors. Another company has estimated that it could reduce its store stock on wire $26,000 if it were not necessary to carry a stock of weatherproof as well as bare wire. It is difficult to arrive at a figure comparing the two types of construction, but from the information gathered by the committee and from estimates prepared covering different types of construction it is believed that the saving would be approximately 10 per cent if bare wire were used rather than weatherproof. Table II shows the saving which would have been made by several member companies in 1925 if no weatherproof wire, excepting No. 8, had been purchased. The companies showing the small saving are the ones using bare wire at the present time quite extensively.

Appearance and Adaptability

Not taking into consideration the additional number of crossarms or height of poles that might be required in congested territory there seems to be no question that the appearance of the bare wire is better than that of weatherpoorf. As it is only a question of time until the insulating compound dries or migrates and no longer protects the braid from the weather, the action of the elements then soon causes the braid to rot and hang from the wire in festoons which attract the eye of the laymen and often cause adverse criticism toward the utility. Bare wire when new often attracts the eye due to the reflection of the copper but this soon becomes dark so that it is much less noticeable than the weatherproof wire. So far as the committee has been able to learn, there are no city or county ordinances requiring the use of weatherproof wire on distribution voltages. General Order No. 64 of the California State Railroad Commission specifies that all service wires must be insulated. Order No. 706 of the Electric Safety Orders issued by the Industrial Accident Commission of the State of California covers yard wiring. This order specifies that conductors of 600 volts or less shall have approved triple-braid or double-braid weatherproof insulation, or an equivalent thereto.

TABLE II. Saving Which Would Have Been Made in 1925 if All Wire Purchased (excepting No. 8) Had Been Bare

Member Company	Estimated Saving if no Insulated Wire Were Used	Per Cent of Total Cost of Wire Purchased
No. 1	*$171,896.00	15.8
No. 2	163,052.00	27
No. 3	2,000.00	.....
No. 4	2,650.00	.....
No. 5	6,000.00	.....

* This figure is for the years 1921-1922-1923; 1925 figure not available.

Testing High-Voltage Insulators and Live-Line Maintenance

By H. H. MINOR

High-Voltage Insulator Testing

A questionnaire was sent to most of the member companies covering their practice in insulator testing and live-line maintenance. Following is an outline of the answers received relating to insulator testing:

1. Q. Do you test pin type insulators after installation?
   A. Two, yes. Five, No.
2. Q. If so: On lines of what voltage?
   A. One, 22 and 24 kv. One, 60 kv.
   Q. By what method?
   A. One, glow-stick. One, spark coil.
   Q. With lines energized or killed?
   A. One, Energized. One, Killed.
3. Q. Do you test suspension insulators after installation?
   A. Five, Yes. Two, No.
4. Q. If so, on lines of what voltage?
   By what method?
   With lines energized or killed?
   A. One, 22 kv. to 165 kv. with glow stick; energized.
   Two, 60, 100 and 220 kv., megger and spark coil, killed.
   Three, 33 kv.; megger; killed.
   Four, 15 kv. and up; megger; killed.
   Five, 11 to 220 kv.; megger; killed.
5. Q. Do you experience any difficulty getting lines out of service for testing?
   A. Four, Yes. Two, No.
6. Q. Have you experienced any difficulty from flashovers caused by testing on live lines?
   A. One, No.
7. Q. Do you test insulators before installation? Describe briefly.
   A. Four, Yes. Three, No.
   Two, A.I.E.E. flashover test.
   Two, megger.

Only one of the companies reporting uses live-line testing methods. They use the glow stick which will be referred to later. Four report difficulty in getting lines out of service for testing. This would indicate that a practical method of live-line testing would be welcomed by those companies. Four report that they test both pin-type and suspension units before installation, using a flashover test in two cases and megger in the other.

An interesting report on the Pacific Gas and Electric Company's practice and equipment used in testing high-voltage insulators by N. P. Carlsen, Jr., follows:

Testing High-Voltage Insulators on the Pacific Gas and Electric Company's System

There are three methods used by the Pacfic Gas and Electric Company for testing high-voltage insulators. They are the megger test for suspension units, the spark coil and portable transformer set for pin-type units. All of these methods are used only when the line is dead.

Megger Set

The megger test is used entirely on suspension units. The megger set consists of a 5,000 megohm megger, a set of prongs and a suitable duplex cord together with a 3-legged leveling stool. The test is performed by setting up the megger at the base of the tower or pole and connecting the duplex cord to the megger and prongs. After this the prongs are mounted on a suitable rod and taken up the pole or tower by a lineman. Prior to contacting the insulators with the prongs a check is made of the resistance of the cord and prongs and the megohm reading is noted. This reading governs the reading at which a unit should be passed or rejected. After making this check the prongs are shorted to ascertain whether the megger is reading correctly after which each unit is bridged by the prongs and the megohm readings recorded. The man operating the megger must be an experienced man who can tell by the readings recorded whether or not to replace a unt. A record is kept of each unit, including the type and manufacture. When a unit is found to be defective it is marked with a blue crayon and changed as soon after testing as possible. The defective units are gathered together and a check test is made on the ground. This check test proves conclusively the condition of the unit.

Spark-Coil Set

The spark-coil test set consists of a high-voltage coil, 12 volts primary to 60 kv. secondary and a vibrator. This coil, while large, is portable enough to permit transporting it along the pole-line right-of-way. The primary source of power is a 12-volt storage battery.

In testing, long leads from the coil are attached to prongs, the coil is set up at the base of the pole and the cords attached after which the prongs are sent up the pole. One shell is tested at a time by placing a prong on the top and bottom ring of cement and applying voltage. The voltage applied is governed by a spark gap adjustment on the coil. A defective shell is picked by the lack of a spark across the gap. When this set is used on a line along a road the set is mounted on a light car. When used in hilly country it is mounted so that two men can carry it from pole to pole.

Portable Transformer Set

The portable transformer set consists of two X-Ray transformers having a ratio of 480/1 and connected in series-parallel. The low voltage is controlled by means of a miniature hand regulator which has a range from 10 to 120 volts, giving a testing voltage of from 9.6 to 114.2.

In testing insulators with this set the units are set upon an insulated platform and the voltage is applied through brass prongs insulated from the hands of the tester by means of bakelite rods 3 ft. long. The voltage applied is measured by a voltmeter in the primary, calibrated for the secondary voltage. This set is used primarily for big reconstruction jobs and for cleaning up warehouse stocks. It has been in use for a period of three years and is giving satisfactory service.

Glow Stick

The Great Western Power Company uses the glow stick in testing on 22 kv. and 44-kv. lines. This device is a development of that company and has proved very satisfactory. It was described in the committee report for 1924-5.

There are available several other devices for live-line testing as well as for testing on dead lines. A brief description of some of these is given in the following paragraphs.

Oscillator Method

For dead-line testing an oscillator method is described by L. A. Wildman of the West Virginia Water & Electric Company in a recent publication as follows:

This testing set as developed consists of the following elements: (a) A 60-cycle step-up transformer; (b) a condenser placed across the terminals of the high-voltage coils of the transformer; (c) an adjustable spark gap; (d) an oscillation transformer, oil immersed, without iron core, consisting of a few turns on the primary and many turns on the secondary. The regulation of this transformer is made as good as can be obtained and, unlike the wireless outfits, there is no dependence placed on obtaining resonance for the ordinary tests; (e) a sphere gap made up of spheres of a diameter equal to the maximum air gap; (f) a suitable reactor to protect the step-up transformer against the damaging effect of short-circuit when a spark takes place on the small gap.

The ratio chosen for the 60-cycle transformer is 110 volts to 13 kv. Both are standard and 13 kv. is high enough to give good effects in the oscillator of the set large enough to test ordinary single-unit insulators. This outfit is capable of producing a voltage represented by a setting of 125 kv. on the sphere gap, and is capable of operating at this value continuously all day long. This is the testing set recommended for general use. For testing single units of lower voltage insulators a smaller set can be built to meet the special needs.

The main frequency of the natural oscillation of such an outfit without the secondary of the coreless transformer in place is about 200,000 cycles per sec. The range of high frequency recommended for testing is from 150,000 to 400,000 cycles per sec.

Maximum rate of discharge should not be less than 1,000 kva. This maximum rate of discharge is not dependent on the kw. rating of the 60-cycle transformer, but depends mostly upon the electro-static condenser.

The foregoing data cover the characteristics of a testing set that is capable of testing most of the insulators in use. It is easily built and gives satisfactory operation.

Buzz Stick

Probably the buzz-stick method of line testing is familiar to most. The tools used consist of a long insulating wooden handle upon which is mounted a metal point or prong. This is called the "feeling stick." A second wooden handle has an adjustable metal horn like a two-tined pitchfork attached to it. This is called the "shorting stick."

The process of testing consists of two distinct steps. First, the feeling-out process and second, the shorting-out process. The first employs the feeling stick and the second the shorting stick. The feeling-out process is used to determine the general condition of the string and to tell if there is danger of causing a flashover by the use of the shorting method. The cap of each successive insulator is touched with the metal prong on the feeling stick and the intensity of the "buzz" from the capacity spark noted. This buzz should grow weaker as the stick is moved away from the conductor. If the same intensity is noted in two adjacent units it may be suspected that one of them is faulty. If too many units seem faulty in a string it may be dangerous to proceed with the shorting-out test. If not, the units are shorted out one at a time. The lack of a spark denotes a faulty unit.

Miscellaneous Devices

Another development is the Doble equipment. This consists of a telephone head-set connected by a hollow tube of high insulating value to a sound chamber in which is located an adjustable spark gap connected through a condenser to terminals that span the unit under test. The spark gap is set for a good insulator and the comparison of sound indicates the condition of the insulator under test.

The Aislometer is a foreign development. It is described in the article by Mr. Wildman referred to above, as follows:

> This is a device and method developed in Europe and one that has given very good resnults on live-line testing. It operates on the electrostatic principle similar to the electrostatic voltmeter and is a simple device consisting of a round tube 4 in. in diameter fitted with a transparent unbreakable cover and mounted on an insulating base carrying two high-tension terminal bushings. Contact is made to the insulator parts by two coiled spring terminals which lead through the bushings to the inner surface of the insulating base and are in contact with a light, pivoted, well-balanced electrostatic element that is free to move and when contacted with the first insulator under test furnishes the indication of a good or bad unit. The indication is positive in that the device when properly adjusted indicates either bad or good and no different grades in between. It is claimed by the manufacturers of this device that it is so built and calibrated that it is practically independent of ordinary atmospheric conditions and disturbing influences that might make testing by other methods less valuable.

A more recent development and an instrument that gives promise of being satisfactory is the Iler Insulator Tester. One of these instruments is being tried by the Southern California Edison Company and E. R. Stauffacher of that company promised a report on its action.

Live-Line Maintenance

The second subject assigned to this committee was live-line maintenance. This also is being studied by a subcommittee of the national overhead systems committee under the chairmanship of J. K. Himes of the Dayton (Ohio) Power and Light Company. It was believed that as far as possible the work of this committee should tie in with that of the national committee. Therefore a questionnaire was sent out, patterned after one sent by Mr. Himes. The answers received were as follows:

Q. Do you do live-line maintenance or construction work?
A. Seven, Yes. One, No.

Q. On what voltage lines?
A. Up to 5 kv.; Seven, Yes. One, No.
5 to 20 kv.: Three, Yes. Five, No.
Above 20 kv.: One, Yes. Seven, No.

Q. What method is used?
A. Up to 5 kv.: rubber, Seven.
5 to 20 kv.: insulated handled tools, Three.
Above 20 kv.: insulated handled tools, One.

Q. What other work than insulator testing is done on live lines?
A. Make hot taps: Six, Yes. One, No.
Replace insulators: Five, Yes. Two, No.
Replace crossarms: Four, Yes. Three, No.
Set poles in hot lines: Five, Yes. Two, No.

LIVE-LINE MAINTENANCE REPORT

SAN JOAQUIN LIGHT & POWER CORPORATION YEAR 1925

	WORK PERFOMED ON LIVE LINES MILES DRIVEN & TIME CONSUMED										IF LINES WERE KILLED TO DO WORK			
DISTRICT	DEAD-END INSULATOR CHANGED	PIN-TYPE INSULATORS CHANGED	FUSE CONTACT INSULATORS CHANGED	BROKEN PINS CHANGED	HOOK JUMPERS MADE PERMANENT	DEADENDS CHANGED FROM PINS TO STRAIN	JUMPERS TRIMMED AND REPLACED	NEW POLES TIED IN LINE	MILES DRIVEN TO PERFORM HOT WORK	HOURS REQUIRED TO PERFORM HOT WORK	TRANSFORMER BANKS OUT OF SERVICE	SWITCHES TO OPERATE	MILES TO DRIVE TO DO SWITCHING	HOURS REQUIRED TO PERFORM WORK DEAD
BAKERSFLD	328	115	40	42	268	8	333	117	1970	457	7488	600	5373	1365
CORCORAN	639	73	0	2	199	3	36	82	2993	428	9135	440	8366	703
DINUBA	440	66	64	4	355	10	202	100	2173	344	5919	762	4358	619
FRESNO	517	110	47	53	656	15	460	123	5040	1007	8522	1141	11935	2179
LOS BANOS	3	8	0	1	0	0	9	14	210	25	28	41	908	75
MADERA	302	32	21	18	74	6	656	45	5173	530	5091	466	7220	869
MERCED	2065	98	22	74	145	0	292	34	6053	735	5546	490	7494	1079
S. JOAQUIN	190	76	3	1	84	6	338	25	1450	264	4727	329	4555	424
SELMA	232	26	10	10	755	42	279	229	6275	795	21216	814	10503	1558
TAFT	423	95	7	6	50	0	115	43	3809	398	10318	437	5511	687
TOTALS	5139	699	214	211	2586	90	2720	812	35146	4983	77990	5520	66223	9555

LABOR SAVED - 572 CREW DAYS - MILEAGE SAVED - 31077 MILES - NUMBER OF INTERRUPTIONS SAVED - 77990 TRANSFORMER BANKS.

CORP. NO. 11214

Q. If live-line maintenance is not done how is service maintained during repairs?

A. Section of loop-feed killed: Three.
Duplicated feed: One.
Shut-down: Two.

Q. On what type of construction is live-line maintenance used?

A. Towers or steel poles: One, Yes.
Wood poles and wodden arms: Six, Yes.
Wood poles and steel arms: None.

Q. Is any record kept of work done by live-line methods?

A. Two, Yes.

Q. If so, can cost of such work be compared with same work being done with lines killed?

A. Two, Yes.

Q. Does record show service interruptions obviated?

A. Two, Yes.

Q. How many men in live-line crew?

A. Two, 3 men. Two, Regular crew.

Q. Do they receive extra pay?

A. No.

Q. Do you have any system to prevent re-energizing a circuit upon which a live-line crew is at work?

A. No.

Q. Have you had any serious or nearly-serious accidents directly chargeable to live-line work?

A. Three, No.

The above answers show that comparatively few companies work lines hot above 5 kv. Of those reporting, only two, the San Joaquin Light & Power Corporation and the Midland Counties Public Service Corporation, do any amount of work on such lines when energized. The San Diego Consolidated Gas & Electric Company reports some live-line work on 11-kv. lines with W. T. safety tools. The tools used by the San Joaquin Light & Power Corporation and the Midland Counties Public Service Corporation are the San Joaquin tools. Both are insulated wooden handled tools. The San Joaquin Light & Power Corporation uses these tools on 11-kv. lines continually and to some extent on 33-kv. lines.

The San Joaquin Light & Power Corporation has the most complete "hot-wire-work" organization of any of the companies reporting. In each of their districts there is a hot-wire crew of two linemen and one groundman. This crew is supplied with a commercial-type truck equipped with tool and material boxes. This crew performs the hot work on all lines above 2.3 kv. and in addition does a great deal of patrol work. They work with the regular line crews or substation construction crews when hot work is to be done in connection with other work. A very complete record of their work is kept by the foreman. This report is rendered to the distribution superintendent's office monthly.

A recapitulation of these reports is made in that office, both monthly and yearly. This report for 1925 is shown in Fig. 1. It may be noted that the character of work done is listed, together with the miles driven and time consumed. The report also includes an estimate of the mileage and time that would have been necessary to perform the same work if the lines had been killed. Also the number of switches that would have been operated and the transformer installations that would have been interrupted is shown. This last is taken from an actual count from the district distribution maps and therefore is not an estimate.

The reports show that live-line maintenance is almost universal on lines up to 5 kv. The same reasons that make this advisable apply to distribution lines of higher voltage as well as to transmission lines in many cases. The only argument that can be advanced against such work on higher voltage lines is that the hazard to the workmen is too great. Mr. Himes indicates that the reports so far received by his committee are to the effect that this reason is given by most for not doing live-line maintenance on lines of higher than 4.6 kv. This argument seems to be refuted by the reports of those using hot-wire tools on medium-voltage lines. The answers received by this committee show that no accidents or near accidents have occurred that can be charged to live-line maintenance. The demand of the public for uninterrupted service coupled with increasing load density, which makes higher distribution voltage advisable, are forcing the operating companies to live-line maintenance. The problem to be solved is to make this hot work as safe to the workmen as is possible. The answers seem to be the selection of proper tools, careful selection and training of the men who use them and close supervision of the work.

Prime Movers Committee Reports*

Liquid and Gaseous Fuels**

The burning of liquid and gaseous fuels continues to be of prime importance to this western geographical section, since these are the only fuels available. Fuel oil is burned exclusively in northern California, natural gas is burned in the San Joaquin Valley, and in southern California. These two principal fuels are burned at different times of the year, natural gas whenever it is available and fuel oil at other times.

In connection with the burning of fuel oil the methods of testing and handling the oil are of considerable interest and brief reference therefore will be made to some of the more important facts in this connection before giving the data gathered in regard to the actual burning of the fuels.

Fuel Oil—Standard Methods of Testing

Four of the companies questioned report the following standard practice, with one or two minor differences, for obtaining the average quality of fuel oil:

(a) B.t.u. content: bomb calorimeter.
(b) Per cent moisture: centrifuge test.
(c) Grit and foreign matter: centrifuge test.
(d) Gravity: Baume hydrometer.
(e) When tested: On each cargo of fuel received.

It is of interest in connection with the B.t.u. content that two companies report a decrease in the calorific value of fuel oil each year. One of these gives a total decrease of 3¼ per cent since 1921.

Fuel Oil Tanks—Fire Protection

Only two companies have fuel-oil tanks with floating roofs and these have been in operation for only a relatively short period of time. The opinion of these two companies, however, is that floating roofs are most desirable for fire protection purposes and are more logical than fire extinguishing apparatus. The former is more in the nature of a prevention than merely a cure as in the case of the latter method.

Fuel Oil Pumps and Heaters

The rotating type of fuel-oil pump is being used in the plants of the San Diego Consolidated Gas & Electric Company and the Southern California Edison Company. These pumps are giving satisfaction and are considered superior to the reciprocating type with the exception, mentioned by one company, that the packing gland requires more attention.

* **J. W. Andree**, Southern California Edison Company, chairman. **C. W. Wiggins**, San Diego Consolidated Gas & Electric Company, vice-chairman. **General Electric Company:** R. F. Monges, E. E. Valk. **Great Western Power Company:** H. S. Markey. **Hunt, Mirk Company:** P. M. Robinson. **Los Angeles Gas & Electric Corporation:** F. R. Knight, R. F. Leefeld, E. G. MacDonald, Weller Reed, J. G. Rollow, C. H. Zeise. **Pacific Gas and Electric Company:** J. M. Brennan, L. D. Burlingame, C. H. Delany, F. T. Ellis, E. E. Mulkey, R. C. Powell, C. E. Steinbeck, J. H. Stott. **San Diego Consolidated Gas & Electric Company:** E. D. Sherwin. **San Joaquin Light & Power Corporation:** A. Y. Meudell, E. A. Quinn, C. P. Rhine, G. W. Thunen. **Southern California Edison Company:** C. P. Coultrap, H. L. Doolittle, L. J. Kraps, F. G. Philo, W. H. Short, W. E. Thompson. **The Southern Sierras Power Company:** V. E. Johnson. **Westinghouse Electric & Manufacturing Company:** R. A. Hopkins.

Report of Subcommittee, **C. H. Delany, chairman. F. T. Ellis, E. A. Quinn, E. D. Sherwin, W. H. Short, C. H. Zeise.

Automatic fuel-oil temperature regulators are used by two companies that report that they are of the opinion that the automatic regulator is not satisfactory over the wide operating range required by a power plant used either wholly or partly for standby purposes. Three of the five companies questioned report that manual control of fuel-oil temperature is quite satisfactory.

Since the introduction of the higher oil pressures used with mechanical atomizing, the importance of some method of detecting leakage in oil heaters has been increased greatly. A very satisfactory arrangement is in use by one company, as follows: The condensate from one heater discharges into a second heater and the condensate from this one discharges into an open tank where any leakage of oil may be detected immediately. When live steam is used for heating, the condensate generally re-evaporates as soon as it is discharged into the atmosphere due to the reduction in pressure. By means of the above series arrangement this objection is eliminated.

Air Preheaters and Water-Cooled Walls in Mechanical Atomizing Furnaces

The Los Angeles Gas & Electric Corporation is the only one on the Pacific Coast having any experience with air preheaters. The type installed by this company in its Seal Beach plant is the tubular, 3-pass type having a heater surface of 9.05 sq.ft. per boiler hp. The following operating data may be of interest.

Temperature of air entering furnace: 250 deg. F. at standby loads. 350 deg. F. at 250 per cent rating.

Reduction in flue-gas temperature: Natural gas 223 deg. to 237 deg. F. Fuel oil 236 to 243 deg. F.

Boiler efficiency: Natural gas with preheater 84.5 per cent. Natural gas without preheater 79.9 per cent. Fuel oil with preheater 88.9 per cent. Fuel oil without preheater 84.7 per cent.

Pacific Coast companies report no experience as yet with water-cooled walls although three companies have stated their intentions of installing such equipment in the near future. It is the opinion of some that although water-cooled walls may not result in any greater gains in boiler efficiency than those obtained with air preheaters, the former practically will eliminate the refractory problem in mechanical atomizing furnaces and permit the use of a quite inexpensive brand of fire brick. It should be borne in mind, however, in connection with mechanical atomizing furnaces that the refractory problem is not serious with air-ventilated settings if the furnace brickwork is protected with a good high-temperature cement. Several brands have been used with varying degrees of success. The Pacific Gas and Electric Company as its station A, used a protective coating over a relatively cheap fireb rick and at the end of five months' operation at fairly high ratings the furnace walls were in very good condition. Unfortunately, it has not been possible to continue the test for a greater length of time due to the load being cut down to standby conditions.

A stabulation of miscellaneous operating data in connection with mechanical atomizing furnaces is given in Table I.

Natural Gas Furnaces

Three plants are equipped for burning either fuel oil with mechanical burners or natural gas. The change from oil burning to gas burning can be made in a few minutes.

The efficiency while burning natural gas is reported by one company to be about 5 per cent less than burning fuel oil with mechanical burners. In Table II may be found some interesting data received from three companies. The San Joaquin Light & Power Corporation burns natural gas exclusively while the other two companies have to burn fuel oil at certain times of the year.

Instruments as an Aid to Combustion Control

The consensus of opinion appears to be that a reliable CO_2 and CO recorder is a great help in obtaining high efficiency. Out of five companies questioned, four are equipped with the chemical type of CO_2 and CO recorder, and two of these report that this type requires an excessive amount of attention. It is felt that the electric type of recorder is more desirable both from the standpoint of simplicity and reliability, although none of the companies have as yet had any actual experience with this type of instrument. One

TABLE I.—Mechanical atomizing furnaces

	Los Angeles Gas & Elec. Corp.	San Diego Cons. Gas & Elec. Co.	So. Cal. Edison Co.	Pacific Gas & Elec. Co.
1. Max. Rating Obtainable with Air Cooled Walls	292 percent	None	Possibilities unknown. Have operated at 315 percent	225 percent natural draft.
2. Experience with water cooled walls	None	None	None	None
3. Does adequate air cooling overcome spalling of Refractories	Yes	..	Not entirely	No.
4. What high-temp. cement or wash is used and with what results:				
(a) As a bond for bricks	"High Fire Bond" very satisfactory.	Argon EB & JM No. 31 very satisfactory.	..	Argon high temp. cement and Stockton mixture, both satisfactory.
(b) As a refractory wash	"High Fire Bond" very satisfactory.	"Durox Fire Glaze" "Argon Facing Cement." No Results yet.	JM No. 31 quite satisfactory.	Durox Fire Glaze, Carboplastic cement.
(c) Method of application	..	Brush and with hands	Brush	Spray Guns.
5. What is Fuel Consumption to keep boiler hot per B. hp.				
(a) Mechanical Atomizing	2545 B. hp. 0.019 bbl. per day.	1166 B. hp. 0.0067 bbl. per day.	1500 B. hp. 0.005 bbl. per day.	
(b) Steam Atomizing		520 B. hp. 0.024 bbl. per day (old boilers—not comparable to the mech. atom. boilers).	777 B. hp. 0.008 bbl. per day.	822 hp. 0.0043 bbl. per day.
6. Does Steam Atomizing Burner permit a higher CO2 than Mech. Burner without causing more smoke?	Yes, natural draft. No, forced draft.	No, natural draft.		Yes, natural draft better by about 1 percent.
7. Reasons for either case		Mech. New boilers..... Steam—Old boilers		Apparently better atomization with steam.
8. Material for Burner Tips	Hardened and tempered tool steel. Renewals are seldom required.	Tempered tips — last about one year.		

TABLE II.—Natural Gas Furnaces

	Los Angeles Gas & Electric Co.	San Joaquin Light & Power Corp.	So. Calif. Edison Co.
1. Max. furnace temp.	2405 deg. F. at 250 per cent rating	2400 deg. F.	2700 deg. F. at 310 per cent rating
2. Maximum boiler rating obtainable	300 per cent	200 per cent	315 per cent.
3. (a) Comp. Efficiency with Fuel Oil—Mech. Atomizing	Gas... 84.5 per cent. Oil.... 89.95 per cent.		2½ per cent higher with oil
(b) Ditto—Steam atomizing			Gas a little better
4. Brick trouble at high ratings	No serious trouble as yet	No high ratings	None
5. Time to change from oil burning to gas burning	About 2 mins. per blower.	10 to 15 mins.	About 5 min. per blower
6. Any pulsations when burning gas with natural draft?	Only when trying to force boilers above furnace capacity	When crowded beyond draft capacity. No pulsations with some type of burners	No.
7. Experience with combination oil and gas burners	Castings of gas burner warp and crack. Oil burner must be extracted while burning gas because oil in burner carbonizes and tips oxidize.		One make quite satisfactory. Another is still being developed.

company is, however, contemplating the purchase of a combination electric CO_2 and CO recorder at this time.

Good results are reported with boiler meters although they require a fair amount of attention in order to keep them in good working order. Two companies report that the recording pyrometer on this meter is not very reliable.

In connection with electric steam flow meters, one company reports very good results with two different makes, while another reports some trouble with the pitot tube plugging and dirt short circuiting resistance rods on one make of meter.

Seal Beach Station, Los Angeles Gas & Electric Corporation; Station Details

By J. G. ROLLOW

The Seal Beach station of the Los Angeles Gas & Electric Corporation is located on the Pacific Ocean at Seal Beach, Calif. The station grounds comprise some 15 acres, practically level. The installed capacity is 31,250 kw. The station was initially operated June 2, 1925. The building includes the turbine, boiler and control rooms and the offices of the plant. The basement elevation is +10 ft., the boiler room +20 ft., the turbine room +41 ft., offices and control room +27 ft., and the roof +119 ft. The foundation is on natural soil with fir piling and a reinforced concrete slab.

Following is something of a brief outline of the equipment and arrangement:

Main Apparatus

Turbine: 1 Westinghouse single-cylinder horizontal steam turbine; capacity 31,250 kw., r.p.m. 1,800 (1,500 for 50 cycle operation). Steam pressure 350 lb., superheat 264 deg. F. One electrically operated speed changer driven by Westinghouse d.c. motor; one auxiliary oil pump driven by steam turbine; two Griscom Russell oil coolers. Turbine main steam line has 1 motor-operated 18-in. Chapman valve, driven by General Electric d.c. motor, connecting turbo throttle to main steam header line.

Main generator: 1 Westinghouse a.c., 37,500 kva. 13.2 kv., 80 per cent power factor, 3-phase, 60-cycle, 1,800 r.p.m. (31,250 kva., 11 kv., 1,500 r.p.m. at 50-cycle operation).

House generator: 1 Westinghouse a.c., 1,562 kva., 2.4 kv., 80 per cent power factor, 3-phase, 60-cycle, 1,800 r.p.m.

Exciters: Two 200-kw. Westinghouse d.c. generators, compound-wound, 300-volt, 666-amp., 1,170-r.p.m., direct-connected to Westinghouse induction motor, 310 hp,. 2.3 kv., 60-cycle, and to Westinghouse steam turbine, steam pressure 350 lb., 1,140 r.p.m., non-condensing.

Main transformer bank: Three single-phase, 12,500-kva. each, oil-filled and water-cooled, 110/13.2 kv., also rated for 50-cycle operation.

Auxiliary transformer bank: Three single-phase delta delta Westinghouse, 2,000-kva. each, 60-cycle, 110-kv., 2.4-kv., delta on 115.5 kv. and delta on 2.4 kv., also rated for 50-cycle operation.

Condenser Equipment

One Wheeler, 2-pass, split-type, surface condenser; cooling surface 45,000 sq.ft. of 1 in.x21 ft. 3¼ in. No. 16 BWG Admiralty-mixture tubes of British American Tube Co., Inc. Condenses a maximum of 300,000 lb. of steam per hour and circulates approximately 50,000 gals. of water per min. Tube plates are of Muntz metal 1½ in. thick. Tubes in top half of condenser are arranged in vertical rows with extra-wide horizontal spacing. Those in the lower half are arranged in diagonal rows with standard spacing. Weight of condenser and contents, under normal operating conditions, is carried partly on the spring supports and partly on turbine exhaust flange, through the connecting piece.

Two 30-in. Wheeler horizontal, double-suction, single-stage, centrifugal circulating pumps each driven by 250-hp., wound-rotor, General Electric induction motor.

Two 6-in. Wheeler centrifugal hot-well pumps, each direct-connected through a flexible coupling to a 100-hp., 2.2-kv., wound-rotor, induction motor having a drip-proof cover. Capacity of each pump 800 gal. per min.

Two Wheeler steam-jet air-pumps, two-stage type, equipped with surface inter-coolers and after-condensers. Surface in inter-cooler 100 sq.ft. Surface in after-condenser 40 sq.ft. 427 ⅝-in. Admiralty-mixture tubes, 2 ft. active length; 2 ft 2½ in. total length. Tube plates of Muntz metal.

Boiler Room Equipment

Three B.&W. water-tube, cross-drum boilers. 25,450 sq.ft. heating surface each, equipped with B.&W. interdeck, three-loop superheaters. Evaporation for each boiler under normal operating conditions is equivalent of 175,600 lb. of water per hour from and at 212 deg. F. Maximum continuous evaporation for each boiler is equivalent of 263,400 lb. water per hour from and at 212 deg. F. Maximum working steam pressure 375 lb., gage at outlets of superheater. Each boiler has 860 4-in. tubes 24 ft. long, made of hot-finished, seamless steel and arranged 43 tubes wide by 20 tubes high. Thickness of tubes: two buttom rows No. 6 BWG; all other tubes No. 7 BWG. Each boiler has six 4½-in. safety valves, steel body with Monel feathers and seats. Fuel burned is oil and natural gas. Boilers equipped with Peabody Fisher wide-range mechanical oil burners. Two Copes feed-water regulators on each boiler.

Two Kinney pumps, 112 gal. per min., driven by G.E. turbine through G.E. reduction gears.

Two sets Braun fuel-oil heaters, each set consisting of three units. Counter-current, floating-head, straight-tube. Oil is passed first through a heating unit which has for a heating medium the condensed steam from the other units, then through to the second unit which has for a heating medium the exhaust steam from turbines driving the fuel-oil pumps, then through the third unit which is fed with live steam controlled by a thermostatic valve adjusted to deliver steam at the required pressure and quantity to bring temperature of the oil up to a working range of 200 to 250 deg. F. Each set has sufficient capacity to heat 54,000 lb. of fuel oil per hour from 60 deg. F. to 250 deg. F.

Three Sturtevant "Turbovane" forced-draft fans; horizontal, ¾ housing; top 45 deg. Capacity at maximum rating, 100,000 cu.ft. per min. at 200 deg. F. with a total pressure of 6 in. of water. Under these conditions there is 2-in. suction at fan inlet and 4-in. pressure at fan outlet. Each fan direct-connected through flexible coupling to G.E. adjustable-speed, brush-shifting, 3-phase motor. Air supply is drawn from outside through pre-heaters and duct line to fans and is conveyed by ducts from fans to boilers.

Two Worthington horizontal feed-water pumps, double-suction, motor-driven, centrifugal, 6-stage, 1,000-gal. per min., speed 1,800 r.p.m., 450-lb. discharge head.

One Worthington horizontal feed-water pump, double-suction centrifugal, turbine-driven, 4-stage, 1,000-gal. per min., speed 2,100 r.p.m., 450-lb.discharge head.

Four Griscom Russell bleeder type feed-water heaters, horizontal water-tube closed-type with floating head. Used in connection with turbine for heating feed water. Four-stage bleeding heating system is used. Condensate is passed first through system which absorbs heat from generator cooling air, from bearing and transformer oil and from condenser air ejectors. It is then passed through a system of four closed heaters in which its temperature is increased to about 360 deg. F. Steam for these heaters is provided by bleeding from turbine.

Fuel Oil Tanks

One steel fuel-oil storage tank; capacity 55,000 bbl., with heating coils and floating roof. Situated above ground.

Two service tanks; capacity 2,000 bbl. each, reinforced concrete. Situated underground.

Two Byron Jackson fuel-oil pumps; 350 gal. per min. each, 140-ft. head, 1,750 r.p.m., direct-connected to G.E. 25-hp., 3-phase, 1,800 r.p.m., induction motors. These pumps pump from storage to service tanks.

Cooling System

Cooling water taken from bay through two traveling water screens. They are self-cleaning type with renewable wire screens, provided with a water spray system for removing debris into a refuse trough. Each screen is capable of cleaning 35,000 gal. of water per min. at normal operating speed. Link Belt Company, manufacturers.

Air Compressors

One Gardner Rix, 4½x4½-in., 300 to 500 r.p.m. Maximum pressure 200 lb., driven by 5-hp. G.E. induction motor.

One Ingersoll Rand 12x12-in., belt-driven by G.E. 75-hp. induction motor.

Turbine-Room Crane

One Whiting Corporation 4-motor, electric traveling crane with main hoist capacity of 100 tons and overload capacity of 120 tons provided with auxiliary hoist having capacity of 20 tons. Span 62 ft. 11 in. center-to-center of runway rails. Top of crane 40 ft. above turbine room floor. Automatic electric brake provided on each hoist, so constructed that it will operate instantly when electric power is cut off or fails.

Fire Fighting Apparatus

One Lux, electrically controlled, 16-tank, carbonic-gas, transformer-oil fire protection system. La France and Foamite chemical engines and 1-gal. Phister extinguishers are installed in different locations throughout plant.

Air Pre-Heaters

Three B.&W. tubular, 3-pass; used in connection with the three boilers. Each pre-heater has ½-in. thick top tube-sheet and ¾-in. thick bottom tube-sheet. There are 1,972 No. 11 gage tubes, 18 ft. long., so arranged that gases pass upward inside tubes and air passes downward outside tubes, making three complete passes over tubes. Total effective heating surface of each heater is 23,025 sq.ft.

Stack

One reinforced concrete stack 375 ft. in height, above the boiler room; 32½ ft. inside diameter at base.

Instruments

Foxboro temperature and pressure gages.

Leeds and Northrup temperature recorders for pre-heater gas.

Simplex venturi meters for water-flow, feed-water and condensates.

Republic flow meters, for natural gas.

Bassler liquid meters for fuel oil.

Tag Mono Duplex CO_2 recorders.

Frahm reed tachometers.

Esterline-Angus recording tachometer. (For speed of turbine and generator.)

G.E. flow-meter, measuring steam to turbine.

Westinghouse graphic meters in control room.

Power Station Heat Balance-Preliminary Report*

By F. G. PHILO and L. J. KRAPS

The trend of proved developments of power-station heat balance and arrangement of station auxiliary equipment is well represented in the Pacific Coast section by the Seal Beach station of the Los Angeles Gas & Electric Corporation and the two sections of the Long Beach steam plant No. 2 of the Southern California Edison Company.

Fig. 1 illustrates the essential points of the heat-balance arrangement of the Seal Beach plant. Fig. 2 gives the heat balance arrangement for units Nos. 7 and 8 of the Long Beach steam plant. Fig. 3 illustrates the heat balance for unit No. 9, Long Beach steam plant No. 2.

Heat-balance arrangements of the later steam stations, of which the above are typical examples, are possible to the fullest degree only by the use of electrically driven auxiliaries. Electric drive has proved thoroughly its economy, dependability and freedom from excessive maintenance.

The use of steam drive now is usually confined to emergency equipment such as fire pumps, relay drive for exciters, emergency boiler-feed pumps and fuel-oil or other pumps the exhaust of which may be used near at hand for heating or drying operations.

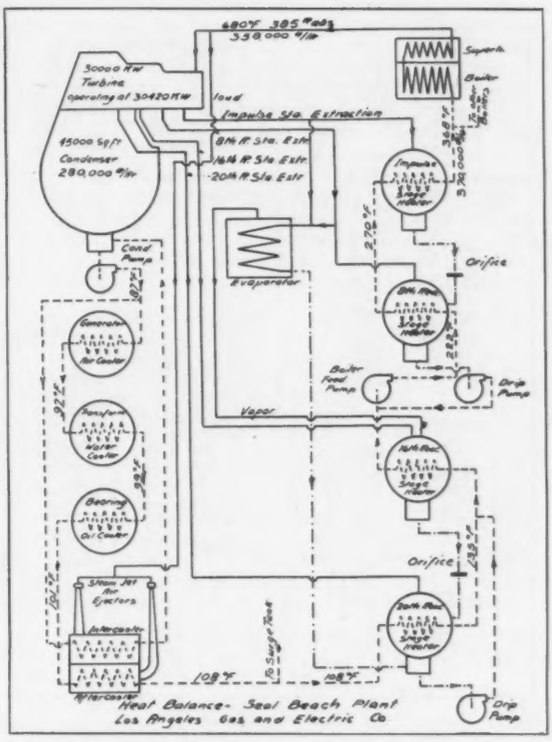

Fig. 1. Heat-balance diagram of the Seal Beach plant of the Los Angeles Gas & Electric Corporation.

Selection of Heat-Balance Arrangement

The proper selection of a heat-balance arrangement should weigh thoroughly the factors of first-cost, operating economy, dependability, flexibility and maintenance. Equipment frequently must be selected and operated in a manner that would not be thermally justified.

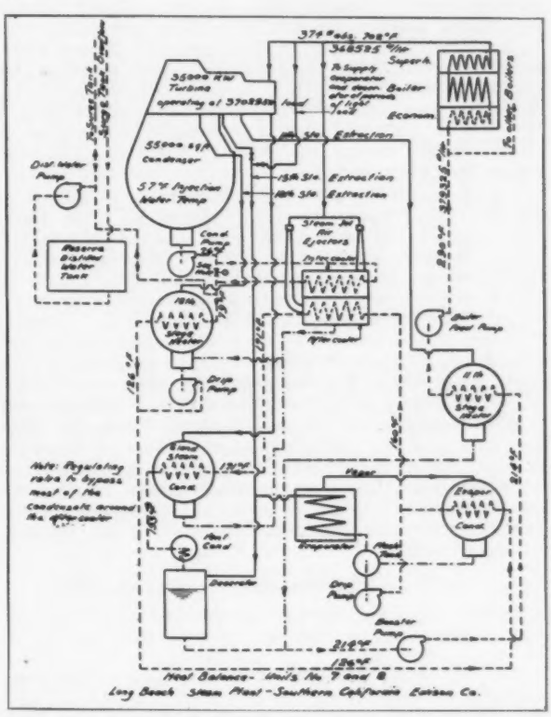

Fig. 2. Heat-balance diagrams of the No. 7 and 8 units at Long Beach steam plant of the Southern California Edison Company.

* Report of subcommittee.

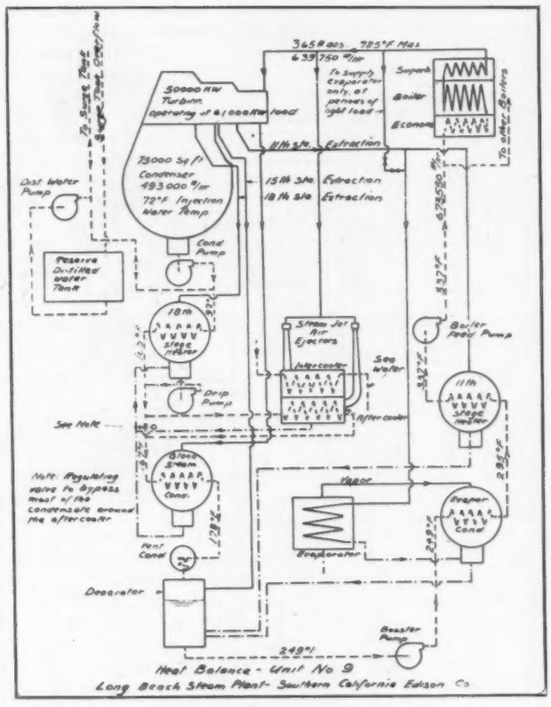

Fig. 3. Heat-balance diagram of the No. 9 unit at Long Beach steam plant of the Southern California Edison Company.

Extraction Heaters

The use of three stages of extraction has become quite general. A fourth stage of extraction is used occasionally, but is possibly justified only in stations of high fuel cost or high load factors. In addition to the normal extraction heaters, processes such as heating, operation of make-up evaporators, and the deaeration of boiler feed are conducted usually by extracted steam.

Steam from a higher turbine stage or live steam through reducing valves may be used for evaporator and deaerator operation during periods of very light turbine load. Evaporators, deaerators and similar equipment usually operate in parallel or series with the normal extraction heater from the stage whose normal pressure and temperature is best suited to the operating conditions required. The economy derived from the operation of evaporators, deaerators, etc., in series with a normal extraction heater is the same as if the entire range of heating from an individual stage took place in a normal heater operating alone.

Fig. 4 shows the pressure-load relation in stages 11, 15 and 18 of turbo-generator No. 8 at Long Beach station No. 2. It is interesting to note that the turbine stage pressures for all practical purposes are straight-line functions of turbo-generator load. This characteristic is very useful in the estimation of stage pressures other than those known. The straight-line relation between stage pressures and turbo-generator loads also facilitates the estimation of stage temperatures other than those known, providing the temperatures to be estimated all are saturated-steam temperatures.

Fig. 5 shows the relation existing between stage temperatures and turbo-generator loads in the same turbine. Extrapolation of stage temperatures may be made from the temperature-pressure relation obtained from the given or calculated stage pressures, providing the temperatures involved all are those of saturated steam.

Cooling of Turbine and Transformer Oil

Turbine and transformer oil may be cooled by sea-water, raw water, condensate or air. The use of raw or river water usually is undesirable as such water usually is either prohibitive in cost or contains large amounts of organic matter and mud. As far as cooling efficiency is concerned the use of sea-water probably is most preferable. However, it has the disadvantage of nourishing various marine animal and vegetable growths which adhere to and very often seriously obstruct piping and coolers.

The possibility of leakage of sea water into oil coolers requires very close watching but never has occurred in the Long Beach steam plant. Barometric legs are used on the sea-water lines leaving all coolers. This arrangement maintains sea-water pressures in the coolers below atmospheric preventing leakage of sea water into the oil system should leakage in the cooler surface develop.

The main argument in favor of the use of sea-water for turbine and transformer-oil cooling is that the temperature of sea-water usually is the lowest available and thus gives the maximum cooling capacity.

Condensate sometimes is used entirely or in conjunction with sea-water to cool turbine and transformer oil. This arrangement has proved quite satisfactory, but it is doubtful whether the complication of piping required for two systems in conjunction with a given generator or transformer is justified.

Cooling Generator Air

Sea water, when available, also is the most efficient cooling medium for generator air. Its disadvantages are the same as noted above. Where the maximum continuous turbo-generator capacity is limited by generator-air cooling the use of water at the lowest temperature increases turbo-generator capacity considerably.

Thermal Gain Effected by the Use of Condensate for Cooling Purposes

Heat picked up by the condensate in the passage through various coolers displaces steam which might have been extracted from the lowest bleed-point of the turbine. The net thermal gain obtained by using condensate for such cooling purposes therefore is a differential between the recovery of miscellaneous heat losses and the gain that could be made in the extraction cycle by using a greater amount of extracted steam in the lowest temperature heater, if these miscellaneous heat pickups had not been made previously.

Steam Jet Air Ejectors

The steam-jet air ejector is a piece of equipment the use of which is not thermally justified, but its dependability and freedom from maintenance have established it in quite general use. The indirect thermal loss occasioned by the slight heating of feed water with the exhaust from the steam-jet air ejectors instead of using bled steam is more than outweighed by the compactness, reliability and low first-cost of this piece of equipment.

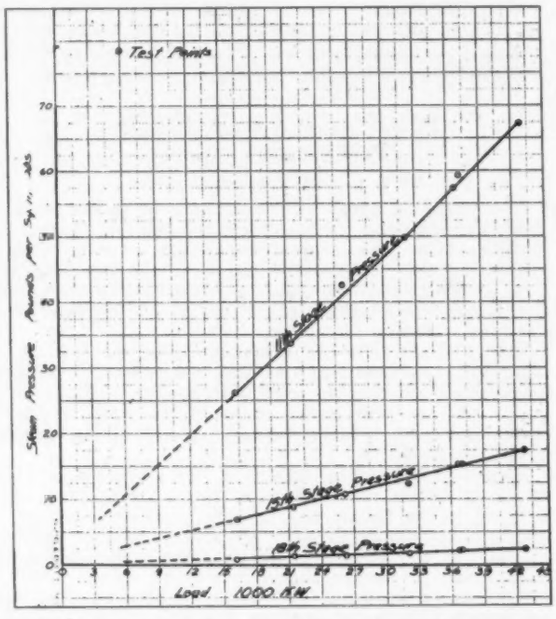

Fig. 4. Stage pressures of No. 8 unit when extracting, Long Beach steam plant of the Southern California Edison Company.

Effect of Feed Water Temperature on Station Economy

If economizers are not used a net thermal gain for the station is made by heating the feed water to the saturated steam temperature existing at the boiler with extracted steam. However, if the economizers are used the maximum boiler-room efficiency is obtained with the lowest feed-water temperatures.

With an arrangement of economizers and extraction heaters the gain from the use of extracted steam is the maximum when the gain from the use of the economizer is at the minimum. Consequently, in such a case there is a maximum extraction temperature to

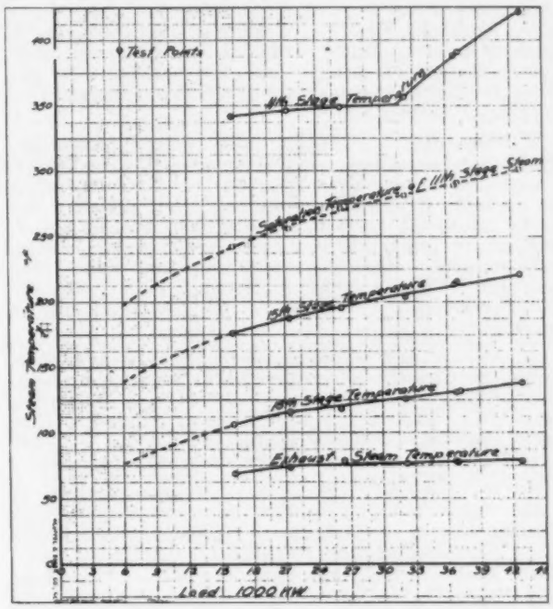

Fig. 5. Stage temperatures of No. 8 unit when extracting, Long Beach steam plant of the Southern California Edison Company.

which a system should go. This temperature usually is about 325 deg. F. in a 350-lb. 700-deg. F. non-reheat station.

Combination of Air Preheaters and Economizers

A combination of air preheater and economizer may be used which largely will combine the desirable features of both the air preheater and economizer. The total space occupied by the economizer and air preheater will be somewhat smaller than that occupied by a large air preheater of equivalent total capacity.

With the completed report on station heat balance the various subjects mentioned above will be dealt with more quantitatively. Considerable operating data also will be included in the final report, which also will jointly cover the subject of Station Auxiliaries.

Midway Steam Plant of the San Joaquin Light & Power Corporation*

By R. A. WALLINGFORD

Station Arrangement—No. 1 Unit

A. Turbine and Generator: Horizontal, impulse-type, Curtis. 250 lb. gage steam pressure. 125 deg. superheat steam temperature. 28-in. vacuum. No bleeder points. Capacity: 10,000 kw. at 0.80 P.F., 12,500 kw. at 1.00 P.F. (See Appendix, Note, 1.) Water-rate curve guaranteed: 5,000 kw.-13.55 lb., 7,500 kw.-12.65 lb., 10,000 kw.-12.5 lb., 12,500 kw.-12.75 lb. Speed, 1,800 r.p.m., 60-cycle, 11.5 kv. Placed in service May 4, 1921.

B. Condenser: 2-pass, surface-type, Wheeler Condenser & Engineering Company. 30,000 sq.ft. cooling surface. 5,729 Admiralty metal tubes, 1 in. outside diameter, 20 ft. 5 in. long. Tube arrangement: uniform spacing in each pass, with steam lanes. Metallic packing with ferrules. Circulating water required for 28½-in. vacuum depends largely upon temperatures and would not justify any definite statement as to volume; however, provision is made for 24,000 gal. per min. Head-loss through tubes approximately 7 lb. when pumping 24,000 gal. per min., varying with volume of circulating water. No electrolytic protection.

C. Air-Removal Equipment: Two-stage jet Evactor with single 8-in. air intake, Croll Reynolds Company, Inc. Position of air pipe leaving condenser: one 8-in. line from side of condenser shell 30 in. below center, under dry-air baffle. No figures available on steam consumption. (See Appendix, Note 2.)

D. Condensate Pumping Equipment: Two single-stage volute, Wheeler Condenser & Engineering Company: One driven by 25-hp., 440-volt G.E. induction motor, one driven by 25-hp., non-condensing-type G.E. turbine 100-ft. pumping head.

E. Turbine Oil-Cooling and Purifying Equipment: Tubular-type Schutte & Koerting fresh-water cooler. R.P. filter-type, continuous bypass oil purifier. (See Appendix, Note 3.)

F. Turbine Air-Washing and Cooling Equipment: Water-curtain type, capacity 30,000 cu.ft. of air per min. Single-stage volute pump driven by 10-hp. motor. Stirling air-purifying and cooling system supplied by Blumfeldt & Ropp Company, Chicago.

G. Exciters: One G.E. motor-driven, 250-hp., 250-volt, 680-amp. One turbine driven through G.E. reduction gear, 3,600 to 1,200 r.p.m.

H. Circulating Water Equipment: One 30-in., 24,000-gal.-per-min. Wheeler Condenser & Engineering Company pump. Drive: 500-hp. Curtis steam turbine through G.E. reduction gear, 3,517-1,060-350 r.p.m. (See Appendix, Note 4.) Four hand-cleaned screens, each approximately 5x5 ft., San Joaquin Light & Power Corporation manufacture. (See Appendix, Note 5. Cooling system: spray pond with 360 2½-in. nozzles. (See Appendix, Note 6.)

I. Instruments, Steam Plant Only: Recording gages for steam pressure and temperature in header; vacuum in turbine exhaust; circulating-water temperature and pressure at condenser inlet; circulating-water temperature and pressure at condenser outlet; condensate temperature. Venturi meter for condensate volume. Indicating gages for steam pressure and oil pressures. Mercury columns for vacuum. (See Appendix, Note 7.)

J. Boilers and Superheaters: Babcock & Wilcox, Stirling-type M30 boilers with steam discharge from center drum. 8,224 sq.ft. heating surface, 260 lb. gage pressure. Babcock & Wilcox superheaters for 125 deg. superheat. Hair-pin tube with cores. (See Appendix, Note 8.)

No economizers. (See Appendix, Note 9.) Pressure drops through superheaters: at 95 per cent rating, 1 lb.; at 120 per cent rating, 1 lb.; at 130 per cent rating, 1 lb.; at 150 per cent rating, 2 lb. Pressure drops through Lagonda automatic stop valve: at 95 per cent rating, 1 lb.; at 120 per cent rating, 1 lb.; at 130 per cent rating, 2 lb.; at 150 per cent rating, 2 lb.

K. Furnaces and Burners: San Joaquin Light & Power Corporation design, natural-gas burners. (See Appendix, Note 10.) 306 burners arranged in six sections evenly divided over floor of furnace with separate air control to each section. Furnace volume: approximately 4,000 cu.ft. Burners installed for 200 per cent of rating in emergency and 150 per cent for normal operation. Furnaces built of Los Angeles Pressed Brick Company brick. (See Appendix, Note 21.) Thickness: side walls, 18 in.; center walls, 30 in.; front walls, 27 in.; rear walls, 18 in.; bridge, 31 in. Only sufficient ventilation of walls to protect steel work. Natural draft. Burners evenly distributed over entire furnace floor, directing flame upward.

L. Stacks: Steel, 90-in. diameter, 95 ft. high above top of boiler setting. No lining. Supported on boiler setting with two sets of g u y s. (See Appendix, Note 11.)

* Report prepared for the prime movers committee of 1924-25. Publication delayed.

M. Fuel Equipment: Pumps and heaters in duplicate. Duplex, 5¼x4¾x5-in. steam pumps from Snow Steam Pump Works, Buffalo. (See Appendix, Note 12.) 5,000-bbl. storage and service tank. Combustion control: pressure governor only, with individual regulation by hand at each oil burner. (See Appendix, Note 13.)

N. Feed-Water Equipment: Two 4-stage, centrifugal, 2,500-r.p.m., 4-in., 500-gal.-per-min. Allis-Chalmers pumps operating at 624-ft. head. Driven by G.E. turbines. Heaters: open, V-notch, recording type. Maximum capacity, 300,000 lb. per hr. Harrison Safety Boiler Works, Cochrane Company. Source of water supply: deep wells on station grounds. Reserve capacity, 50-bbl. tank on roof. No evaporators or deaerators.

O. Instruments, Boiler Room: Bailey boiler meter for each of eight boilers, recording steam flow, air flow and flue-gas temperatures. Mono-duplex CO_2 recorder for the eight boilers. One indicating and one recording pressure gage on steam header. One indicating pressure gage on feed-water line. One indicating pressure gage on low-pressure gas line. One indicating wattmeter on turbo-generator.

P. Piping Layout-Fan Type: Steam velocities approximately 6,000 ft. per min. at full load. No anchors. Expansion bends, single offset quarter-bend at boilers. Expansion U-bend in cross connection.

Q. Signal System: Solenoid-operated whistle with control at switchboard, for calls. Used also for signalling to firemen when making load changes. Also Klaxon horn in engine room operated from firing station in boiler room.

R. Foundation and General Data: Foundation; concrete mat, reinforced with railroad iron, 4 ft. thick, resting on hard-pan. Company has no data to offer on burning oil. Natural gas is fuel used and supply has been sufficiently satisfactory to give little call for use of other fuels. Plant is equipped for burning oil in case of emergency. For this purpose three Hammel burners are placed conveniently for quick insertion, connecting both steam and oil unions with sets of wrenches always kept with burners. When burning oil, burners are front-shot and gas-burner floor acts in a capacity similar to checker floor of oil-burner installations.

S. Gas Burners: No new developments. Capacities range to maximum of 200 per cent of boiler rating. Efficiencies range up to 84 per cent. Brick work stands up exceptionally well without any special construction or materials. (See Appendix, Note 10.)

Station Arrangement—No. 2 Unit

A. Turbine and Generator: Horizontal, reaction-type, Parsons. 250-lb. gage steam pressure. 125-deg. superheat steam temperature. 28-in. vacuum. No bleeder points. Capacity: 12,500 kw. at 1.00 P.F. (See Appendix, Note 15.) Water-rate curve guaranteed: 7,500 kw., 13.7 lb.; 10,000 kw., 13.3 lb.; 12,500 kw., 13.7 lb. 1,800 r.p.m., 60-cycle, 11.5 kv. Placed in service Aug. 1, 1922.

B. Condenser: Two-pass, surface-type, Allis-Chalmers. 30,000 sq.ft. cooling surface. 6,300 Muntz metal tubes, 1 in. outside diameter, 19 ft. 3 in. long. Tube arrangement: uniform in each pass with steam lanes. Metallic packing with ferrules. Circulating water required for 28½-in. vacuum depends too much upon temperature of circulating water to justify statement as to volume; provision is made, however, for 24,000 gal. per min. Head-loss through tubes, 3 lb. when pumping 24,000 gal. per min. No electrolytic protection.

C. Air Removal Equipment: Two 2-stage jet Evactors in multiple, with double 8-in. air intake, Croll Reynolds Company, Inc. Position of air pipes leaving condenser: two 10-in. flanged connections, one in each end compartment coming from side of condenser shell 10 in. below center, beneath dry-air baffle. Steam consumption, 3,000 lb. per hr. at 250 lb. and 125 deg. superheat. (See Appendix, Note 16.)

D. Condensate Pumping Equipment: Two single-stage volute Allis-Chalmers, one motor-driven, one turbine-driven. Capacity, 500 gal. per min. 100-ft. pumping head. 1,750 r.p.m. Size of driver, 25 hp.

E. Turbine Oil-Cooling and Purifying Equipment: Copper-tube, fresh-water, 6 sq.ft. Allis-Chalmers oil cooler R. P. filter-type, continuous bypass oil purifier. (See Appendix, Note 17.)

F. Turbine Air-Washing and Cooling Equipment: Water-curtain type. 30,000 cu.ft. per min. Sturtevant Company.

G. Circulating-Water Equipment: 24,000-gal-per-min. Allis-Chalmers pump driven by 475-hp. Allis-Chalmers turbine through Westinghouse reduction gear, 2,200 to 550 r.p.m. Pumping head, 60 ft. (See Appendix, Note 18.) Screens same as Unit No. 1. (See Appendix, Note 5.) Cooling system consisting of cooling towers, 25,000 sq.ft. area with seven trays above surface of water. Designed and built by San Joaquin Light & Power Corporation engineers. (See Appendix, Note 6.)

I. Instruments — Steam Plant Only: Recording gages for steam pressure and temperature in header; vacuum in turbine exhaust; pressure and temperature of circulating water at condenser inlet; pressure and temperature of circulating water at condenser outlet; condensate temperature. Venturi meter for condensate volume. Recording gage for feed water temperature. V-notch meter for feed water volume. Indicating gages for pressures of oil, steam and turbine exhaust.

J. Boilers and Superheaters: Connely, type M30 boiler, D. Connely Boiler Company. 8,250 sq.ft. heating surface. 260-lb. gage pressure. (See Appendix, Note 19.) Foster-type superheaters. Hair-pin tube with cores and finished surface. Designed for 125 deg. superheat. (See Appendix, Note 20.) No economizers. (See Appendix, Note 9.)

K. Furnaces and Burners: Same as described for Stirling boilers of Unit No. 1. (See Appendix, Note 10.) Furnaces of Los Angeles Pressed Brick Company brick. (See Appendix, Note 21.) Thickness: side walls, 18 in.; front walls, 30 in.; rear walls, 18 in.; center walls, 30 in.; bridge, 31 in. Ventilation of walls as required by manufacturer to protect structural steel work in setting. No ventilation of floors. Natural draft.

L. Stacks: Same as described for Unit No. 1. (See Appendix, Note 11.)

M. Fuel Equipment: Same as described for No. 1 Unit.

N. Feed-Water Equipment: Four-stage, 2,700-r.p.m., 750-gal.-per-min., 635-ft. head Allis-Chalmers centrifugal pump driven by 200-hp. Allis-Chalmers turbine. (See Appendix, Note 22.) Heaters: open, V-notch recording type, 250,000 lb. per hr. maximum; designed and built by San Joaquin Light & Power Corporation engineers. Make-up from deep wells on station grounds. Reserve capacity, 50-bbl. tank on roof. (See Appendix, Note 23.)

O. Instruments—Boiler Room: Identical with Unit No. 1 except there are six boilers instead of eight. (See Appendix, Note 24.)

P. Piping Layout, Fan Type: Same as Unit No. 1. Hand-operated valves.

Q. Signal System: Described in connection with Unit No. 1.

R. Foundation: Same as for Stirling boiler of Unit No. 1.

Appendix

(1) Maximum rated capacity of No. 1 turbine is 12,500 kw. at 100 per cent P.F. under stated conditions of steam pressure, temperature, vacuum, etc., however, 13,100-kw. loads have been carried on this unit for various periods of time.

(2) The 2-stage jet Evactor recently installed on No. 1 Unit (replacing 3-stage steam-jet air-pump installed originally with this unit, but which apparently was of insufficient capacity to maintain the desired conditions except at very light loads), has been very successful in improving the conditions of operation over those encountered with original installation.

(3) The only data available on this cooler at the present time is a set of instructions for cleaning and installing. It is a very satisfactory operating piece of apparatus, never having failed to function with perfect satisfaction and never having required cleaning or repairing in the least.

(4) Original 290-hp. turbine of this pump equipment, which was increased to 400 hp. by remodeling nozzles, blading, etc., has been replaced by a 500-hp., D-51, G.E. turbine and reduction gear. A great improvement in the operation and conditions maintained on No. 1 Unit has been noted since the above changes in this pumping equipment were made.

(5) There is little occasion for any other than the simplest of hand-operated screens. During some times of the year they do not require cleaning more than once or twice a week. However, in the late summer there is a form of algae that forms quite rapidly during the latter part of each day and comes to the screens, suspended in the water, fast enough to compel cleaning about every two or three hours between noon and midnight. Between midnight and noon there is scarcely any collection upon the screens.

(6) After a year of operation with the spray-pond cooling system and with numerous comparisons with the tower system in use at Bakersfield plant under almost identical conditions it was seen that the towers would be most satisfactory for our use. That is why the tower system was installed for use with the No. 2 Unit.

(7) Changes to be recommended in this set of instruments, would be:

(1) Dual record gage for steam pressure and temperature.
(2) Dual record gage for circulating water inlet and outlet pressures.
(3) Dual record gage for condensate and feed-water temperature.
(4) Dual record gage for circulating-water inlet and outlet pressures.
(5) Add steam-flow meter to turbine steam line.
(6) Add steam-flow meter to auxiliary steam line.
(7) Add dual record for pressure and temperature of auxiliary exhaust line.

(8) It is to be recommended that boilers be designed for pressures high enough that the proper pressure for efficient operation at all times may be maintained at the turbine throttle, allowing a variable pressure on the boilers considerably below the necessary safety-valve setting. This would minimize the tendency toward safety-valve leakage and consequently cutting, and maintain the highest turbine efficiency.

(9) Where fuel is as cheap as the natural gas used at this plant there is little occasion for the expenditure necessary for economizers. The saving that would be possible would not justify their installation.

(10) In the case of the gas burners installed under our boilers the capacity is somewhat limited due to restricted area at the air intake of the draft pit. The remedying of this and the addition of a few slight refinements in the burners themselves are to be recommended, though the present installation is highly satisfactory.

(11) There is one stack for each battery of two boilers.

(12) Natural gas is the fuel normally used. The pumps, heaters, etc., listed constitute our emergency oil-burning equipment.

(13) Our oil storage tank of 5,000 bbl. is connected directly to the oil line of the Union Oil Company through a meter and for this reason, and due to the fact that oil was for emergency use only, it was considered that this was sufficient capacity.

(14) The capacity of this turbine is rated at 12,500 kw. at 100 per cent P.F. but it has great overload capacities, having carried over 15,000 kw. for short periods and having carried over 14,000 kw. for days at a time under conditions far from ideal. This capacity for overload certainly is to be commended for emergency use, even though the plant efficiency be lowered somewhat while making use of it. The average load for the month of August, 1924, was 13,619 kw. The average load for the entire month of September, 1924, was 13,996 kw.

(15) Installation of a larger size air pump than was used on the No. 1 Unit has justified fully the extra cost. Here we maintain a vacuum very close to the theoretical for the temperatures maintained.

(16) The cooling capacity of this piece of apparatus apparently is not as great as that in use on the No. 1 Unit, and requires a greater amount of care and cleaning.

(17) In connection with the circulating-water pumping equipment there is, in addition to that mentioned for No. 1 and No. 2 Units, an electrically-driven Byron-Johnson pump of 24,000-gal.-per-min. capacity with a 400-hp. motor which can be used on either No. 1 or No. 2 condenser in place of the turbine-driven pump.

(18) Connely boilers were installed on the No. 2 Unit after having used the Stirlings at the Bakersfield plant for a number of years and on the No. 1 Unit at Midway plant for a year. The change was made with due consideration by the management after all data, prices, etc., were submitted by competing companies. Their operation has been quite satisfactory, being easier to handle and showing less tendency toward priming. The latter no doubt is due to their discharging steam from the rear drum instead of the center, as in the Stirlings. However, there was a greater tendency for developing trouble with leaky seams, rivets, flanges, etc., than in the case of the Stirlings. Six boilers were installed on the No. 2 Unit whereas the No. 1 Unit required eight, six being the number required for operation of each unit with two for spare. The units being paralleled for normal operation permits the location of the spare boilers wherever desired.

(19) Foster superheaters are installed with the Connely boilers and give us a degree of superheat somewhat in excess of that expected. They are standard equipment with Connely boilers.

(20) Though this brand of fire brick may not have shown a high degree of satisfaction with some users that burn oil with mechanical atomizers, they have given our company very satisfactory service in connection with our gas-burning equipment.

(21) The feed pump installed with this unit was designed for capacity to feed the boilers of both No. 1 and No. 2 Units and is so operated whenever the plant is up to or near capacity. This operation is satisfactory and easily handled due to the two units being operated in parallel as a single unit.

(22) This heater operates in parallel with the larger one of No. 1 Unit whenever the load is greater than the capacity of the larger one. When the plant load is within the capacity of the No. 1 Unit heater, the No. 2 heater is cut out of service and the No. 1 heater allowed to carry the load for the entire plant.

(23) To the list of instruments shown for the boiler room it is to be recommended that the following changes be made:

(1) Bailey boiler meters: Omit the flue-gas temperature recorder and substitute steam temperature recorder. Instances have come to our attention where there was evidence of a priming boiler that could not be located readily, and on account of this the trouble was not remedied as quickly as would be the case were individual temperature recorders used on the boilers. Moreover the flue-gas temperature recorder is the part of the Bailey boiler meter that is the most unreliable and most difficult and expensive to repair.

(2) A mono-duplex CO_2 recorder should be installed for not to exceed four boilers.

Underground Systems Committee Reports*

Method of Repairing an Unleaded Submarine Power Cable

By GEORGE H. HAGAR

The all-rubber 11-kv. submarine cable laid by the Great Western Power Company in 1922 is a little over 7 miles long. It stretches from the north shore of San Francisco to Brooks Island where it connects with the overhead line from the Golden Gate substation in El Cerito. Since this cable was put into operation only one case of trouble has been due to electrical breakdown. The procedure in case of trouble is as described in the following paragraphs:

After clearing the cable from the rest of the system a preliminary location test is made using a decade-resistance set. This preliminary test is rarely reliable due to the fact that the cable automatically is cleared from the system before the conductors have a chance to burn together, leaving an unknown high resistance at the fault. Generally it is necessary to separate a generator from the rest of the system, connect the same to the cable and bring up the voltage until approximately 400 to 450 amp. are flowing into the cable. This is continued until the ammeters show a steady reading. This burning takes from 20 min. to 2 hr. It is done in an attempt to burn the conductors together at the point of fault. Another location test then is made checking the resistance between conductors, between conductors and ground, and between telephone wires, in order to get an approximate location of the fault. While the cable barge is picking up the cable at this approximate location and placing it in the sheaves for under-running, an ordinary sign flasher is connected to the shore-end and resistance adjusted so that a direct current of from 120 to 150 amp. flows between the conductors and ground. On the cable barge is a turning coil of a split-coil type and a telephone head set. The presence or absence of the click in the telephone shows whether the barge is between the fault and shore, or beyond the fault. The cable then is underrun until the bad section of cable is on the barge.

The bad section then is cut out and a new piece spliced in. The splice requires the following material:

* **P. E. Chapman,** Pacific Gas and Electric Company, chairman. **N. B. Hinson,** Southern California Edison Company, vice-chairman. **Coast Valleys Gas & Electric Company:** G. A. Peers. **General Electric Company:** M. H. Schnapp. **Great Western Power Company:** G. H. Hagar. **Los Angeles Bureau of Power and Light:** M. O. Bolser, C. H. Jenkins. **Los Angeles Gas & Electric Corporation:** O. C. Miller, E. R. Northmore. **Pacific Gas and Electric Company:** H. H. Buell, G. L. Hill, H. G.Keesling, R. P. Lutzi, H. C. Moyer, Paul Suransky. **San Diego Consolidated Gas & Electric Company:** K. B. Ayres, D. J. Kelly. **San Joaquin Light & Power Corporation:** H. H. Minor. **Southern California Edison Company:** T. J. Lovell. **The Southern Sierras Power Company:** A. C. Putnam. **Standard Underground Cable Company:** Vinton Smith.

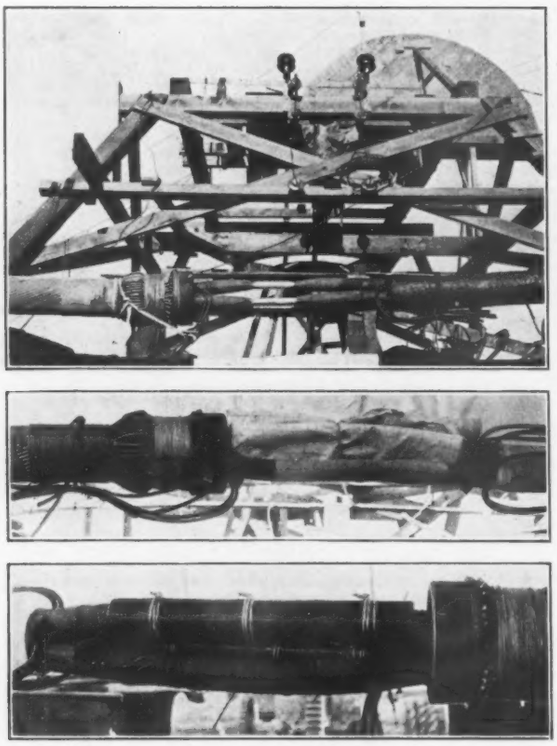

Fig. 1 Showing (above) the first steps in making the cable splice. One end of the turnbuckle sleeve is in place, armor served ready for zinc collar. Rubber penciled down, copper sleeve sweated on. For convenience the telephone pairs are tied back out of way. (Center) rubber tape in place. (Below) rubber-filled tape added to one leg; other legs completed ready for vulcanizing, iron moulds in place. Uniform thickness of rubber insured by use of three moulds.

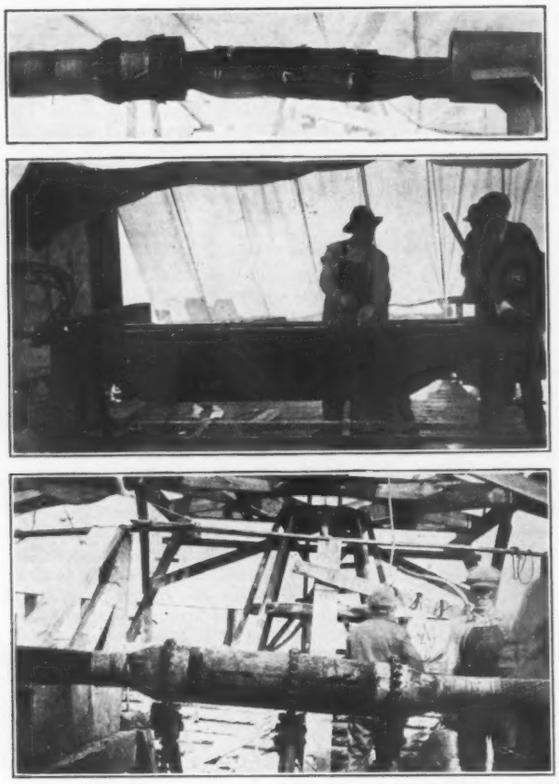

Fig 2. (Above). Vulcanizing process. Tank is filled with beeswax which is maintained at 140 deg. C. for an hour and 40 min. Steam from the hoist engine is used to heat the tank. (Below.) Final screwing-up of the sleeve after the zinc collar has been cast around each end. Purpose of zinc collar is to fasten armor wires solidly to sleeve in order that all strain may be passed through sleeve and none placed upon copper conductors.

3 copper splicing sleeves, 500,000 circ.-mils.
1 lb. solder.
5 lb. 40 per cent rubber tape.
½ lb. rubber-filled tape.
3 sq.ft. of fish paper.
1 roll of white linen tape.
4 gal. of compound.
1 roll of asbestos tape.
1 turnbuckle sleeve.
50 lb. zinc spelter.

An Example of Electrolysis*

By PAUL SURANSKY and J. R. JENSEN

Station L, situated on Ocean Avenue east of Junipero Serra Boulevard, San Francisco, is an automatic substation with supervisory control from Station H on Walbridge Street east of Schwerin Street.

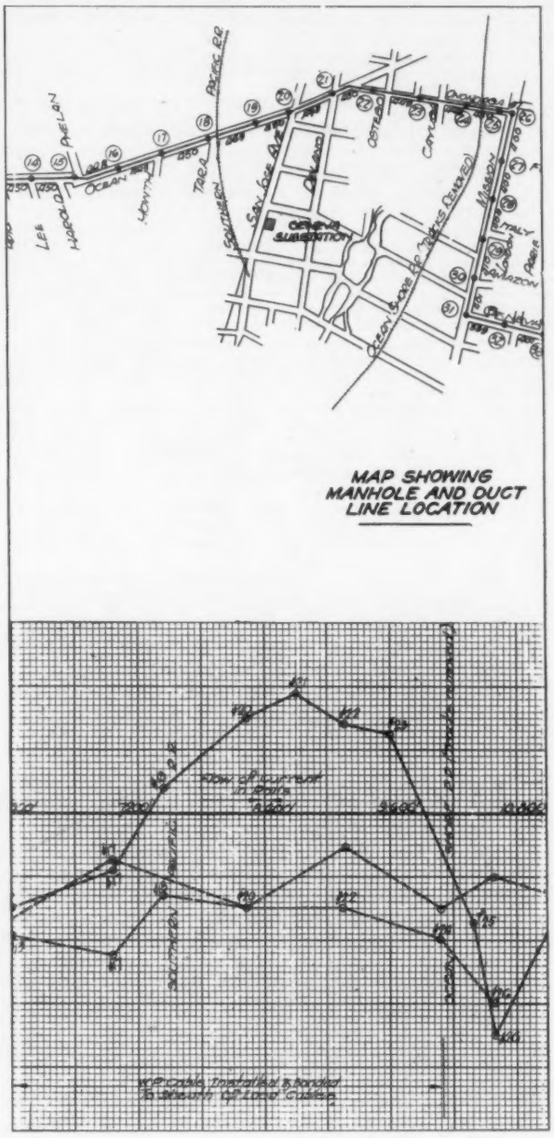

Fig. 1. Curves showing voltage relations of rail, cable sheath and water mains.

There are two 11-kv. cables and one telephone cable between stations H and L. These cables are 500,000 circ.mil in size and of 6/32x4/-32 in. paper insulation and 9/64 in. lead sheath. These cables supply energy to station L where it is stepped down to 4 kv. for distribution. The telephone cable is a 10-pair No. 19 B.&S. lead-covered cable, insulated with double-wrapped dry paper, 2 paper tapes over core, and 3/32-in. lead sheath. The telephone cable is used for supervisory control of Station L by Station H and for telephone communication between these stations.

* Special report of the Underground Systems Committee.

The distance between stations L and H by the route of the duct line is 4½ miles.

The duct line from Station L to Ocean Avenue and Paloma Street (manholes No. 1 to No. 3), consists of concrete ducts; from Ocean Avenue to Paloma Street to Mission and Onondaga Streets (manholes No. 3 to

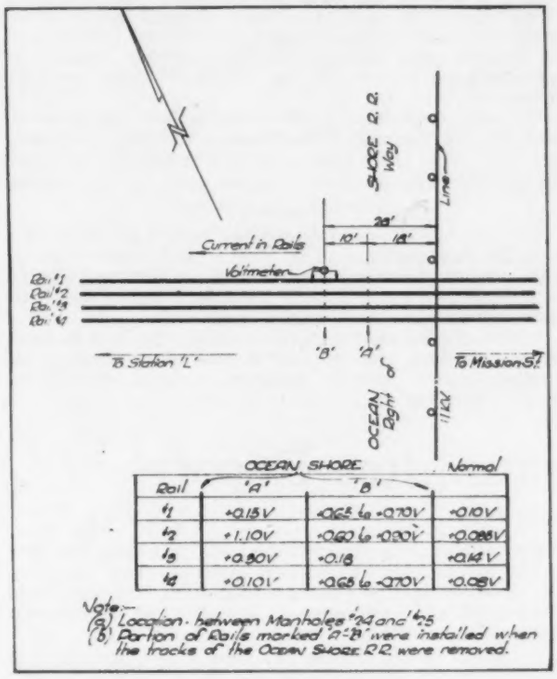
SHORE R.R. Way
Line
20'
10'
10'
Current in Rails
Voltmeter
Rail #1
Rail #2
Rail #3
Rail #4
To Station 'L'
'B'
'A'
To Mission St.
OCEAN Right of
11 KV
OCEAN SHORE
Normal
Rail | 'A' | 'B'
#1 | +0.15 V | +0.65 to +0.70 V | +0.10 V
#2 | +1.10 V | +0.60 to +0.90 V | +0.088 V
#3 | +0.30 V | +0.18 | +0.14 V
#4 | +0.10 V | +0.65 to +0.70 V | +0.08 V
Note:—
(a) Location between Manholes #24 and #25
(b) Portion of Rails marked 'A'-'B' were installed when the tracks of the Ocean Shore R.R. were removed.

Fig. 2. Tests of bonding of street railway rails where Ocean Shore Ry. rails were removed.

26), consists of fiber ducts and from Mission and Onondaga Streets to Station H (manholes No. 26 to 58), consists of concrete ducts.

The three cables were installed and tested as satisfactory on Dec. 4, 1925. As Station L was not ready

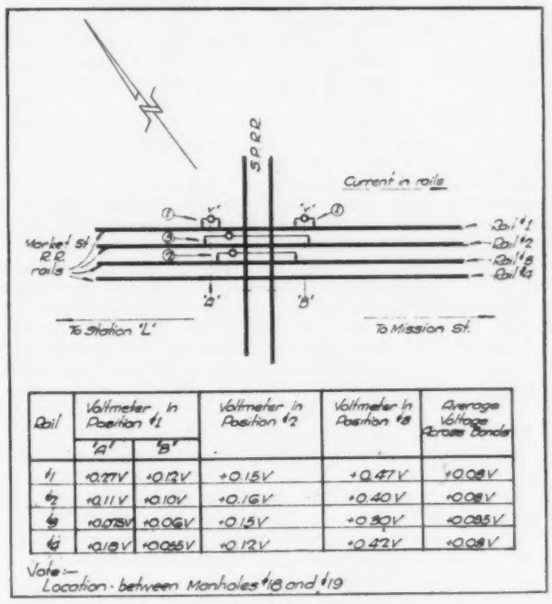
S.P.R.R.
Current in rails
Market St. R.R. rails
Rail #1
Rail #2
Rail #3
Rail #4
'A'
'B'
To Station 'L'
To Mission St.
Rail | Voltmeter in Position #1 'A' | Voltmeter in Position #1 'B' | Voltmeter in Position #2 | Voltmeter in Position #3 | Average Voltage Across Bonds
#1 | +0.17 V | +0.12 V | +0.15 V | +0.47 V | +0.08 V
#2 | +0.11 V | +0.10 V | +0.16 V | +0.40 V | +0.08 V
#3 | +0.075 V | +0.06 V | +0.15 V | +0.30 V | +0.085 V
#4 | +0.18 V | +0.055 V | +0.12 V | +0.42 V | +0.08 V
Note:—
Location between Manholes #18 and #19

Fig. 3. Tests of bonding of street railway rails where Southern Pacific tracks cross street railway.

for supervisory control at that time it was operated manually and the telephone or control cable was not placed into service. On Feb. 20, 1926, the station was ready to be operated by supervisory control. However, when tests were made on the control cable it showed a grounded condition. Upon investigation it was found that that portion of the control cable located between the Southern Pacific railway crossing and the old Ocean Shore railroad right-of-way (see Fig. 1, manholes No. 18 to No. 24), had been damaged by electrolysis and that the conductors were grounded.

This portion of cable was laid in a fiber duct line. The topography of the surrounding territory is such that all water drains toward this portion of the duct line. As the grounded condition was discovered after a rainstorm it is believed that previous to this the lead sheath of the cable had been destroyed by electrolysis and the water collected in the low portion of the duct worked its way into the paper insulation thereby grounding the conductors.

Voltage Tests

The duct line for its entire length between the stations parallels the rails of the street railway. In order to determine the extent of electrolysis voltage tests were made between cable and rail. These voltage relations are shown in Fig. 2. The lead sheaths of the three cables were bonded together at the time they were installed.

The curve obtained by plotting the above voltage readings indicated that the current, which had been returning on the cable sheaths, was leaving the cable and going to the rails between a point west of the Southern Pacific railway crossing, west of manhole

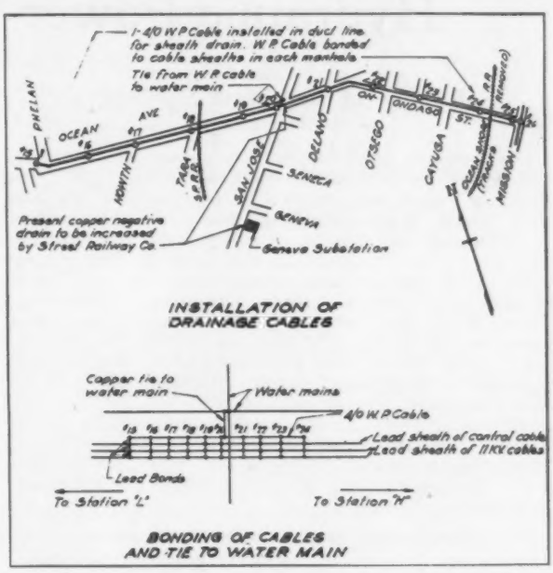
1-4/0 W.P. Cable installed in duct line for sheath drain. W.P. Cable bonded to cable sheaths in each manhole
Tie from W.P. cable to water main
PHELAN
OCEAN AVE
HOWTH
SAN JOSE
SENECA
DELAWARE
ONONDAGA
CAYUGA
OCEAN SHORE R.R. (Abandoned)
MISSION
Present copper negative drain to be increased by Street Railway Co.
Geneva Substation
INSTALLATION OF DRAINAGE CABLES
Copper tie to water main
Water mains
4/0 W.P. Cable
Lead sheath of control cable
Lead sheath of 11 KV cables
Lead Bonds
To Station 'L'
To Station 'H'
BONDING OF CABLES AND TIE TO WATER MAIN

Fig. 4. Sketch showing installation of drainage cables, bonding of cables and tie to water main.

No. 18, Fig. 2, and a point west of the Ocean Shore railroad right-of-way, west of manhole No. 25, Fig. 2. This indicated that the cable sheath was being destroyed by electrolysis and that the condition would have to be remedied because the cables had been installed only 68 days previously and the sheath of one had been destroyed in that time.

Bond Tests

Since the curve obtained by the above voltages tests indicated that the current began to leave the cable sheaths at the Southern Pacific railway crossing and the old Ocean Shore railroad crossing, which had been removed, it was surmised that poor bonding of the rails may have been the cause of this condition. Therefore bonding tests were made at each locality and in the vicinity of same. The results of these tests are listed and the methods of testing are shown in Figs. 2 and 3. The tests show that at the Southern Pacific railway crossing, Fig. 3, the voltage drop across bonds was from 2 to 9 times the drop across the average bond in the vicinity, thus indicating that the bonds were very poor. At the location where the old Ocean Shore railroad crossing had been, tests showed the voltage drop across the bonds was from 2 to 8 times the drop across the average bond in the vicinity, thus indicating that bonding was very poor. It is believed

that the bonding at both of these localities is a divided contributing cause of the current leaving the cable sheath for the rail.

The Remedy

In order to reverse this flow of current from the cable sheath to the rail between manholes No. 17 and No. 25, a No. 4/0 weatherproof cable was installed between manholes No. 15 and No. 24. Larger bonds for tying the cable sheaths together were installed in each manhole and in turn these were soldered to the 4/0 cable, see Fig. 4. By doing this a low-resistance path was provided for the stray current to flow. The 4/0 cable was in turn connected to the water main nearby, near manhole No. 20, Fig. 4. This tie was necessary because the voltage from rail to water was +4 volts, from cable sheath to water +8 volts and rail to cable sheath —4 volts. By making the tie, the cable sheaths and water main were brought to the same potential and the voltage from rail to cable sheath changed from a —4 volts to a +4 volts. Voltage tests from rail to cable sheath and from rail to water were made for the entire length of the duct line and the results obtained were plotted. These are shown partially in Fig. 2. The curve indicates that wherever the current had been leaving the cable sheath for the rail, it has been reversed so as to flow from the rail to the cable sheath. Also the flow of current was from the water to cable sheath, thus indicating that the cable sheaths no longer would be subjected to electrolysis.

When the tie was made between the 4/0 cable to which all the cable sheaths were bonded and the water main, a flow of 120 amp. to the latter was indicated. With the 4/0 cable, two lead sheaths of 9/64 in. thickness and one lead sheath of 3/32 in. thickness it is believed that sufficient current-carrying capacity is provided for the return of whatever stray currents there may be.

It is the intention of the street railway company to increase the drainage from San Jose and Ocean Avenues, see Fig. 4, to their Geneva Street substation in order to provide a low-resistance return path to the station.

Summary

The two 11-kv. cables probably have had their lead sheaths damaged somewhat due to the electrolysis in the section described heretofore, but not sufficiently to go through their 9/64-in. sheaths. These cables to date have operated without failure.

It is believed that with the remedy applied as outlined and from the voltage results obtained that no further trouble will be experienced from electrolysis in this locality.

Hydraulic Power Committee Report*

Resume of Important Subjects

By WALTER DREYER

The program of the hydraulic power committee as selected at the Fresno meeting in March, 1925, included at least one subject in each of the various parts which, when combined, make up the modern hydroelectric development. Listing these subjects and parts of the development in the order in which they occur as the water flows downstream we first have the reservoir, where the study involved is Evaporation Losses from Reservoirs. Next in order were two studies on the subject "Prevention of Silt Deposits in Conduits and Restriction in Flow Due to Animal and Vegetable Growth in Conduits. At the lower end of the development several subjects were studied; namely, Discussion of Penstock Design, Effect of Speed Regulation and Water Hammer on the Design of Relief Valves, Penstock and Surge Tanks, Vibration in Hydraulic Machinery, and Mechanical Reliability of Hydroelectric Plants.

Evaporation Losses from Reservoirs

This study is a thesis undertaken by N. W. Cummings of the California Institute of Technology, with financial assistance from the P.C.E.A. The main conception underlying the study is that evaporation is controlled by the energy which becomes available for that purpose. An instrument termed the pyranometer, which measures solar energy, was purchased by the association for the use of Mr. Cummings.

Energy is supplied to a water body by the sun and is discharged by evaporation and back-radiation. Furthermore, the air over the water may either contribute heat or carry it away according to the direction of the temperature difference. Also, since the heat capacity of a water body is large great quantities of heat may be absorbed thus decreasing for a time the amount available for evaporation. Or the water may cool, and thus increase the heat available for evaporation while the cooling is going on.

The various processes by which heat may be acquired or disposed of are: (a) Radiation from the sun; (b) Evaporation; (c) Back radiation to the sky; (d) Convection and conduction to the air; (e) Storage in the water body itself.

It should be noted that (a) always is a source, (b) and (c) always are sinks except on those rare occasions when the water-surface is below the dew-point and condensation occurs; while (d) and (e) may be either sources or sinks.

Reflection is not counted because we are thinking only of the energy which actually gets into the water. Any heat carried to or from the water body by inflowing or outflowing water is neglected in this discussion.

If we have two bodies of water both exposed to the same sky conditions and both thermally insulated then (a), radiation from the sun, will be the same for both and (c), back-radiation to the sky, will be the same except for difference of temperature. It can be shown easily that the back radiation increases by about ½ colorie per hour per square centimeter for every degree increase of temperature. It is easy to take account of (e), the stored heat in the water body itself, by measuring subsurface temperatures. The only really troublesome thing then, that is involved in a comparison of the behavior of two water bodies is (d), the exchange of heat between water and air. Fortunately this part of the problem has been solved from the theoretical standpoint and experimental tests verifying the theoretical conclusion have been made. The ratio between the heat lost or gained by conduction and convection to or from the air and that lost or gained by evaporation or condensation is given by the following equation:

$$R = 0.46 \frac{t_e - t_s}{P_e - P_s} \times \frac{B}{760}$$

when t_e and t_s are the temperatures of air and water, respectively, and P_e is the absolute humidity in millimeters of vapor pressure, P_s the pressure of saturated vapor at the temperature of the water surface and B is the barometric pressure.

The experimental work on this subject has not been completed at this time, but such experiments as have been made appear to conform closer to the new theory than any theories based solely on temperature, wind or humidity.

It is hoped that in the practical application of this method it will be necessary only to measure the solar radiation data with the pyranometer, and the average depth and temperature of the water at the

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beginning and end of the time interval. The latter may be changed into terms of heat energy and, if the water has heated up, this value subtracted from the solar energy gives the amount of energy available for evaporation.

Prevention of Silt Deposits in Conduits

This subject is one which seems somewhat difficult to terminate as field studies must be made in the run-off season. Some work was done in the spring of 1925 on the Bear River canal of the Pacific Gas and Electric Company but the results, as affording data from which scientific deduction could be made, were somewhat negative. It is intended to continue the study during the next year.

Restriction in Flow Due to Animal and Vegetable Growth in Conduits

This report was submitted at the Kansas City meeting of the N.E.L.A. and will be published in the convention report of the national hydraulic power committee.

The subject has been divided into the two general divisions of vegetable, and animal growths. It is to be regretted that very little practical information at present is available on either. The subject of vegetable growths, particularly algae has been, however, thoroughly treated in engineering literature from the standpoint of the sanitary engineer.

Such general information as has been thought desirable properly to outline the subject has been extracted from the papers of the American Water Works Association. These data have been supplemented by all available published data together with some experience of the operating companies in California on the practical problems of reduction of flow and methods of removal of obstructions.

An outline of the subjects covered in the report is as follows:

(a) Algae and Moss

Types.

Variation of growth with season.

Methods of elimination:

Copper sulphate, chlorine, excess hydrate alkilinity.
Copper sulphate and screens.
Copper ions by electrolysis.
Covering conduits from sunlight.

Effect on restriction of flow:

Tieton Canal, "n" increased from 0.013 to 0.0155.
Hat Creek Flume, "n" increased from 0.013 to 0.0248.
San Joaquin Light & Power Corporation Concrete Canal, capacity reduced to 80 per cent of normal for several monthss a year.

(b) Aquatic Flowering Plants

Location	Value of Kutter's "n" Without Growth	With Growth
Miami and Erie Canals	0.036	0.047
	0.025	0.030
	0.025	0.032

(c) Insect Growth

Hellgramities (salmon fly larvae) in the Kern Three project of the Southern California Edison Company attach themselves to the walls of tunnels and pipe lines; capacity in some instances has been reduced 8 per cent. Removed only by scraping with wire brush. Prevention of growth by painting with smooth asphalt paint.

Discussion of Penstock Design and Operation

The result of this study is to be forwarded to a national subcommittee on this subject. The purpose is to bring up to date the 1923 report of the N.E.L.A. committee on penstocks, which was compiled by the Pacific Coast Section under H. L. Doolittle of the Southern California Edison Company.

The work covered in the new study is as follows:

(1) Head and formulae used in determining thickness. Three methods for determining pressure and four formulae for determining strength. Working stresses used by various companies.

(2) Factor of safety.

(3) Expansion joints: New developments and applications at Big Creek, Drum, Copco No. 2, Balch, Buck's Creek and Pit Three.

(4) Specials: Manifold at Big Creek No. 3, Manholes at Balch, Buck's Creek and Pit Three.

(5) Air valves: New types, Coffin and Simplex. Prevention of freezing.

(6) Standard flange details.

(7) Reinforced concrete pipe: Rock Creek crossing of Pit Three tunnel.

(8) Wood stave pipe: Saddles and supports for Copco No. 2 and Klamath Falls East Side Plants.

(9) Revision of specifications for riveted pipe (time of "holding on" rivets decreased).

(10) Painting of penstocks: Past experiences and present practice. Data on experimental coatings.

(11) Specifications for welded, banded and seamless pipes.

Effect of Speed Regulation and Water Hammer on the Design of Relief Valves, Penstocks and Surge Tanks

This subject was selected at Fresno as the principal study for the year 1925-26. The report was forwarded to the Kansas City meeting and will be published by the N.E.L.A. as a serial report after some slight revision and possible addition of experimental data.

An outline of the work covered is shown below. The appendix on water hammer by R. S. Quick of the Pelton Water Wheel Company is considered to be particularly constructive as it enables the designer of water wheels and penstocks to obtain in a rapid manner the values of pressure rise due to closing turbine gates or penstock valves.

(a) Speed Regulation.
Mathematical discussion with test data on runaway speed at Leevining Creek plant.

(b) Effect on Design of Relief Valves.
For tangential wheels.
For reaction turbines.

(c) Effect on Design of Penstocks.
Acceleration of flow and pressure drop.
Deceleration of flow and pressure rise.

(d) Effect on Design of Surge Tanks.
Advantages of surge tank in bettering speed regulation and presenting undue pressure rise.
Factors affecting design of surge tanks.
Pressure rise when closing turbine gates.
Acceleration of flow, general requirements of various companies.

(e) Appendix, Comparison and Limitation of Water Hammer Theories, by R. S. Quick, Pelton Water Wheel Company.
Derivation of general formula for pressure rise.
Approximate formulae.
Comparison of formulae.
Chart for calculating pressure rise by the general, or elastic water-column theory.

Vibration in Hydraulic Machinery

This study, made by Roy Wilkins of the Pacific Gas and Electric Company, was forwarded to the Kansas City meeting and will be published in the convention report of the national hydraulic power committee. The report divides such vibrations into three general classes which, together with their causes and effects, are listed below:

I—Periodic Vibrations (25 to 400 cycles per second).
(a) Cause
1—Pressure reaction.
2—Close clearance and high specific speed.
3—Runner and guide vane combinations.
(b) Effect.
1—Weakening of structures.
2—Weakening of penstocks.
3—Pitting (incidental in design).
4—Loss of efficiency.

II—Non-Periodic Vibrations Due to Flow Conditions.
(a) Cause.
1—Draft tube surges.
2—Air.
3—Extreme variations in head.
(b) Effect.
1—Penstock breathing.
2—Major shocks or pounding.
3—Bearing troubles.

III—Vibrations Due to Mechanical Unbalance.
(a) Cause.
1—Usually caused by blocking part of runner with foreign material.

The report includes experimental data on vibrations of the first type together with a description of apparatus developed by Mr. Wilkins which permits of exploration of any part of the turbine, recording the pressure changes on a chart by means of the oscillograph.

Mechanical Reliability of Hydroelectric Plants

A nation-wide study on this subject was initiated by the eastern geographic division in 1924. The data obtained from 25 plants in the Pacific Coast section have been forwarded to the eastern subcommittee.

In addition, a summary of the operating experience in our geographic division has been made for these plants for the years 1924 and 1925, and it is intended to continue the work for at least four more years.

An analysis of each year's operation is given, for the following items:

Service time.
Idle time.
Outage time (a) in demand, (b) not in demand.
Reserve time.
Demand time.
Capacity factor.
Output factor.
Service demand availability factor.

Particular attention is given to an analysis of the causes of outages, which are broadly divided into four general groups. These groups are divided further to trace the specific cause of trouble. The classification is as shown below:

(1) **General Hydraulic Causes.**
Ice or trash, floods, penstock or canal, headgate or intake, miscellaneous other causes.

(2) **Water Wheels and Auxiliaries.**
Runner, turbine valve, turbine gates, guide bearings, thrust bearings, governor system, pressure regulators, draft tube lubrication system, vibration, inspection, general overhauling, miscellaneous other causes.

(3) **Generator and Appurtenances.**
Vibration, lubrication and oil leakage, rotor or field, armature iron or winding, exciter and rheostats, ventilation system, cleaning, inspection, other causes.

(4) **Electrical Causes Beyond Generator.**
Switches, bus, transformers, outside transmission.

The study, when finally completed, will afford specific data to be used in making comparisons between the mechanical reliability of steam and hydro plants since the prime movers committee already has made a similar study for steam-electric units. It further will permit the making of comparisons between the several types of hydroelectric units, impulse wheels, vertical reaction turbines and horizontal reaction turbines. Closer study will trace the more frequent causes of trouble with the result that improvements in design unquestionably will be made in order to remove the causes of such outages.

Subjects Selected for Study for Year 1926-27

In line with the policy of making the work of the Technical Section continuous the subjects to be studied next year were selected by the committee at the 1926 Fresno meeting and the work already started under J. M. Gaylord, vice-chairman, of the Southern California Edison Company.

The subjects selected are as follows:

(A)—New Subjects.
(1) Handling of stored water.
(2) Continuous measurement of flow of water.
(3) Operating experience with trash racks.
(4) Pressure tunnels.
(5) Penstock valves.

(B)—Old Subjects to Be Continued.
(1) Continuation of study on Mechanical Reliability of Hydro Plants.
(2) Continuation of study on Evaporation from Reservoirs.
(3) Continuation of study on Prevention of Silt Deposits in Conduits.
(4) Continuation of study on Water Hammer, with particular emphasis on experimental data.
(5) Continue study on Painting of Penstocks, including data from more recent inspections.

Commercial Section Reports

Merchandising Committee Reports*

The merchandising subcommittee has studied the situation in the territory covered by the P.C.E.A. in reference to sales of appliances by dealers and power companies. After a careful analysis it feels that at this time no positive recommendations can be made for changes in the policy of any of the power companies toward merchandising; it believes that this is a matter that can best be handled by each individual company. A general summary of its findings follows:

Some Methods of Power Company Merchandising Small Appliances

The introduction of the household electrically operated refrigerator and its possibilities as load builder, has called the attention of power companies to the possibilities of increased demand for current through sales of other appliances. Many household surveys have been made in different sections of the country, resulting in a surprising lack of ownership of small appliances, particularly where such sales had been left entirely to the electrical dealers, showing that some activity on the part of the power companies was necessary to boost such sales.

Four methods of sales have been tried. The first is where the power company has widely advertised cut prices and not in any way attempted to assist dealer sales, resulting in the discouragement of dealer activities. While this method has usually resulted in large sales, it frequently led to deficits in the merchandising department, and it is doubtful if in the end the results obtained were justified, particularly if at any time the power company desired to stop merchandising there was no one to actively continue the work, leaving matters worse off than at the start.

The second method was more constructive. Where the power companies advertised and sold small appliances at the regular list prices this did not interfere with dealer sales but on the contrary assisted them, as it continually called the appliances to the attention of the prospective purchaser and while some customers preferred to purchase from the power company, many others bought from the local dealer so long as he maintained the same price and guarantee. The objection to this plan was that often the dealer, in an endeavor to undersell the power company, would either cut the price or sell an inferior and less expensive first cost article, resulting in some dissatisfaction.

The third method was the most successful. Here the power company widely advertised the appliances, selling them in general at list prices, allowing dealers to purchase from them at their cost for cash, such appliances as they were advertising and selling. In this manner dealers were given the advantage of the power company's purchasing power, and prevented from cutting prices, as they refuse to sell any dealer at their cost who habitually cut the retail price. Where special prices were made, the dealer was amply protected as to margins. One company with a large number of customers notifies all with monthly bills that at the first of the following month it will sell one appliance for a special cut price and that after a certain number has been sold the regular price will be effective.

The fourth method was an intensive campaign either with or without dealer assistance. Considerable newspaper and other advertising was used; crews were put out with stock carried on auto trucks and immediate delivery of sales made. These crews called once a month as far as possible in their territories and became a regular expected caller at the homes. All appliances were sold at list. The results are reported

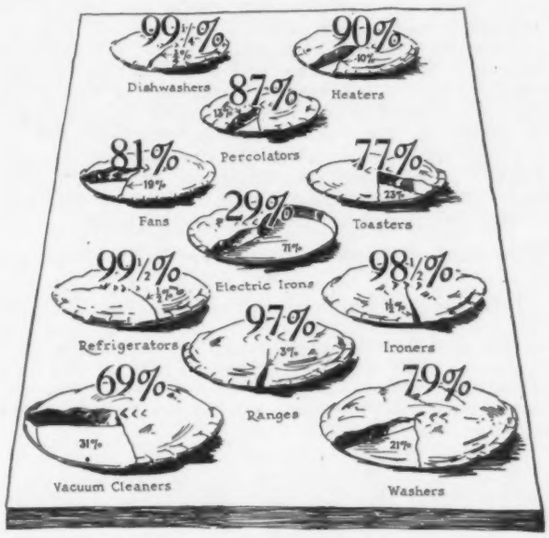
*Merchandising Committee: J. W. Wrenn, Great Western Power Company, chairman; George W. Barker, Allied Industries, vice-chairman; E. S. Alexander, Alexander & Lavenson Electric Supply Company; H. H. Courtright, Valley Electrical Supply Company; R. G. Holabird, Western Electric Company; J. C. Hobrecht, J. C. Hobrecht Company; Arthur Kempston, Majestic Electric Appliance Company; Frank Pollard, Heesman Pollard Company; R. T. Stephens, Pacific Gas and Electric Company; G. B. Schuyler, Johnson Washer Company; R. E. Tompkins, Pacific States Electric Company; C. J. E. Watson, Landers, Frary & Clark.

as satisfactory and financially profitable. This plan is still in use.

Objections to Power Company Merchandising Small Appliances

The following objections regarding central station merchandising are sometimes voiced:

1. A feeling that this is not the business of a power company but should be left to dealers, manufacturers and jobbers.
2. Difficulty of securing and training salesmen for a department with which they are not familiar.
3. Amount of money involved in carrying stock and accounts.
4. Merchandise loss in depreciated and obsolete stock.



Saturation of electrical appliances in wired homes as compiled by Electrical Merchandising. The large figures show the percentages of homes still waiting to be equipped.

5. Complaints from consumers who would ordinarily be satisfied if appliance was purchased from a dealer.
6. Tendency on part of customers to postpone payment on appliance purchased from power company.
7. Difficulty in rearranging accounting system and office force.
8. Little or no room for display or warehousing.
9. Objections by dealers who feel this should be left to them.

Recommendations for Power Companies Who Intend Merchandsing Small Appliances

The committee recommends that where power companies intend merchandising small appliances that they adopt the following methods in full:

1. Purchase all supplies from local jobbers who carry stocks in quantities sufficient to secure the best prices, this in preference to trying to obtain lower figures from manufacturers and being compelled to themselves carry extra stocks which require investment with possible loss through becoming obsolete and shopworn.
2. Decide upon a definite program for the year during which the sale of one certain appliance will be particularly pushed during each month.
3. Arrange with all dealers in the territory to prominently display this appliance in their windows and show cases with price cards thereon for the first week of the month in which the appliance is to be sold.
4. Arrange with all dealers to carry a stock of the appliance and to purchase same in small quantities from the power company for cash before delivery at power company's cost.
5. Secure and carefully train sales force with the idea of public relations as well as sales in mind. Sales force should be paid regular salary and a small bonus on all sales over a stipulated amount.
6. Advertise widely in local newspapers that the articles may be secured from the power company or your dealer for a definite stipulated price for the particular month in which the advertising appears.
7. Mail broadsides describing appliance, its use and care, so as to arrive a few days ahead of your salesman notifying customer that he will call and show appliance. This requires one special employee continuously.
8. All appliances should have a cash and time sales price; if sold on time, payments should be made collectible with regular electric bill. (Dealers may not like this at first but as long as customer is willing to pay more for time purchases which dealer cannot economically carry, he will have no objection once he understands it.)
9. Provide one or more light auto trucks to accompany sales crew on which a stock of appliances can be carried for immediate delivery, principally of the appliance whose sale is being pushed that month, but some others as well, as sales of other appliances can frequently be made and delivered at once, saving time and extra cost of later delivery.
10. Each crew and truck reports every night, turning in all orders and cash collections and receiving order on storekeeper for new supply of merchandise to replace that sold and delivered. Chew leader is responsible for any losses through shortage of stock on trucks.
11. Complete but simple accounting system must be laid out for crews to enable them to account for all orders and deliveries promptly and must include the necessary orders on the storekeeper and charge slips for billing. These can be merely extra duplicates of sales tags.
12. To prevent power company from acting as general jobbers, no merchandise is to be sold dealers except the one appliance which is being pushed for the month and that only for cash with the orders; this prevents dealer from laying in an oversupply to carry him for balance of year during which time he must purchase from his regular jobber at regular prices.
13. As far as possible preference should be given to manufacturers who put up their goods in individual cartons. This keeps surplus stock from deteriorating, which is a serious matter in any company.
14. Personnel required:
    Manager appliance sales to generally supervise.
    Clerk to mail broadsides, answer phone calls, keep track of sales, etc.
    Crew leaders to be paid salary and bonus.
    Crews of 6 men to be paid salary and bonus.
    One or more sales clerks for office sales.
15. Hold meetings of all employees before plan is put in effect and ask their co-operation in giving it publicity and assistance in carrying it out.

Recommendations Where Power Company Does Not Merchandise Small Appliances

1. Appoint one employee to devote his whole time to program.
2. Arrange with jobbers and manufacturers to carry out with assistance of their salesmen, program of one appliance a month and general exhibit of such appliance in all store windows and counters first week each month.
3. Follow plan of power companies who merchandise in adopting sale of same appliance they do for the month, in this manner making program easier for jobber and retailer.
4. Attend all meetings of dealers and keep before them the necessity of co-operation if success is to be secured.
5. Use such advertising space as available to call attention of public and assist dealers.
6. Mention monthly program in company organ and suggest employees use their influence among those they come in contact with.

To enable dealers and power companies to accurately visualize the small percentage of saturation of electric appliances and the enormous opportunities for sales, we are reproducing page 6064 of Electrical Merchandising for Februay, 1926, which brings forcibly to attention the fact that the sale of electric appliances as compared with their possibilities has been very small.

Appliance Merchandising from a Manufacturers's Viewpoint

By G. B. SCHUYLER

In considering such a broad subject it is necessary to determine:

A. Who is selling electrical appliances? After finding out exactly who is responsible

B. What kind of a job are they doing? If the results aren't satisfactory

C. What steps, if any, can be taken to improve the situation for all concerned? There are:

1. The central station who is interested in load and public relations.
2. The manufacturer who is interested in a greater sale of his product.
3. The jobber who is interested in volume.
4. The electrical and non-electrical outlets that are interested in immediate profits.

I will endeavor to take the subject up in this order. Proof of the statements made will be either referred to or by the data and figures shown in supportiing material.

Who Is Selling Electrical Appliances?

1. In large cities where the central stations are merchandising, appliances are sold by various types of outlets in the following order:

Central stations.
Department stores.
Specialty house.
Contractor dealers.
Electrical stores.

For example, in Denver, a city where the central stations are doing a real job of selling, appliances are sold in the following proportions, as shown in a survey printed by Electrical World in 1924:

	Per Cent
Central stations	41.2
Department Stores	29.0
Electrical dealers	26.4
Hardware dealers	3.4

Surveys made in small Western cities, where the central stations are merchandising, published in Oct. 15, 1924, issue of the Journal of Electricity, show that contractor dealers actually sold more appliances than the central station. A similar survey conducted by the Electrical World shows the same results.

2. Compare this situation with the results in large cities where the central station is not merchandising. Here appliances are sold in the following order:

1. Specialty dealers.
2. Department stores.
3. Electrical shops.
4. House furnishing stores.
5. Hardware stores.
6. Contractor dealers.

Using San Francisco as an example, sales are in the following proportion:

	Per Cent
1. Specialty stores	32.4
2. Household furnishing	20.1
3. Department stores	16.0
4. Electric shops	13.2
5. Hardware stores	9.0
6. Contractor dealers	3.8
7. Balance of outlets	5.5

(Results from Electrical World survey, 1924.)

These figures show that where the central stations do not merchandise, the bulk of the business goes to non-electrical outlets.

San Francisco is an example. Here the electrical stores and contractor dealers are only getting 17 per cent of the volume. For further proof of this conclusion you are referred to numerous surveys printed in recent numbers of the various McGraw-Hill publications.

As California is a state in which the central stations, prior to Jan. 1, 1926, have adopted a "hands off" policy, the appliance business is going to non-electrical outlets and if they aren't doing a satisfactory job for all concerned, who is to blame? They are making their immediate profit and seem to be satisfied.

Those of us who are selling washing machines have found that the electrical contractor-dealer as a factor is fast fading out of the picture. We do not depend on him. It has repeatedly been said that the reason the central stations do not take an interest in lamp socket devices is because of respect to the electrical dealer, he still being considered a factor in the sale of appliances. The electrical contractor-dealer in general is out of the washing machine picture with the result that the non-electrical dealer is getting the business. Eighty per cent of the washing machine business in California is going to 5 non-electrical accounts. Has the "hands off" policy helped the electrical dealer in this case? It appears to the writer that the present policy will eventually drive the sale of appliances into the hands of non-electrical outlets.

Often the non-electrical dealers sell an inferior grade of small appliances which are improperly serviced with correspondingly poor results to the consumer, which does not help the electrical idea.

What Kind of a Job Is Being Done in the Appliance Field?

Take washing machines as a case at point. Nationally the number of machines is increasing. Twenty-sx per cent of the wired homes of the nation have washers. If all the 612,074 washers sold in 1924 were placed in newly wired homes, 34 per cent of the new homes purchased washers—showing an increasing use in these homes of 8 per cent.

A larger number of washers and all other appliances are in use in California per 100 residential lighting customers, than any other state. With 4 per cent of the population and 8 per cent of the wired homes, California sells 10 per cent of the washing machines. Thirty-five per cent of the residential lighting customers in California use washing machines, as shown by a Journal of Electricity survey. With washing machine sales in the state of 61,900 in 1924, representing 32 per cent of the new residential lighting customers, California sales are falling short 3 per cent, while nationally, sales have increased 8 per cent. Since this is true regarding washers, there is probably a similar loss in other appliance sales.

I can readily realize that the central stations aren't greatly worried over the loss of that 3 per cent from strictly a load standpoint, a washer being worth only about $2 per year to a power company. At that, the new washer connected load represents about $123,800 to the utilities and I take it that all such items help.

But this paper isn't dealing with this problem strictly on a load basis. A washing machine should be of primary interest to a power company because:

1. In the first place it is one of the three preferred appliances of the housewife; these being the flat iron, vacuum cleaner and washing machine. This was brought out by a questionnaire sent to 5,000 housewives to which 2,600 replied. The sooner Mrs. Housewife buys these three appliances, the sooner will she get the percolator, waffle iron, toaster, etc., which builds the load that you are so anxious to get on your lines.

2. I have heard a lot about "public relations." If you sell a washer to a housewife who has been doing her own washing and relieve her of that drudgery, you will do more for your public relations in that household than all the books that have been written on the subject. Ironing, sweeping and washing are the most disagreeable jobs in the house. This is the reason for the expression of preference for the iron, sweeper and washer. The sale of these appliances will make her hardest work easier and will really make her a booster for the "electric idea."

3. There are more electric irons in use than there are wired homes. A washer in these homes insures you of the maximum revenue from the iron. An iron, where there is a washer in the home is worth more

than $12 per year to the power company. Also the washer paves the way for quicker introduction of the electric ironing machine with its 1,000 watts of connected load, a market with only a 2 per cent saturation at present.

Granting that I have shown that

A. Non-electrical outlets are selling the bulk of appliances in California and

B. That the results obtained are not wholly satisfactory from several angles and that appliances even with low load factors are of primary importance to the power companies,

What Steps, If Any, Can Be Taken to Improve the Situation?

If you don't sell lamp socket appliances, it is to your interest to help others do so.

1. Do your own employees use a wide range of electric appliances? Have surveys been made to determine if they do? Their homes should be nearly 100 per cent electrical. Every inducement should be offered your employees to electrify their homes, including washing machines.

2. Display lamp socket appliances on the floors of your district offices. There is where the consumer should be able to go to see a display of reputable makes of appliances. They will go there if you give them half a chance. Where else should they go, a drug store? They are selling washing machines in a drug store in Tacoma. Washing machine sales in California could be brought up to a figure far above the 35 per cent mark if the central stations put more co-operation behind the dealers, jobbers and manufacturers.

3. The sales force canvassing for electric refrigerators and ranges already in the field, is a great potential sales force for irons, vacuum cleaners, washers, and other appliances. It would seem logical in canvassing for large load builders that the salesman should see how far along the house is with the electrical idea. If the housewife hasn't an iron, vacuum or washer, I think she should be sold one or all of these articles first. They certainly save more labor than a range or refrigerator. By telling her the convenience of these three important appliances and by getting her to use them, you will make a real electric booster of her and an asset to your public relations. This sales force could be a real factor in selling them. I don't know what their instructions are but we have made several unsuccessful attempts through the utilities to get their sales force to visit our factory and learn something about washing machines so they could at least answer questions intelligently and other manufacturers have probably had the same experience. This co-operation would not cost the companies anything and would help the appliance business generally.

4. Allow advertising material to be available at the district offices and feature lamp socket appliances occasionally in your newspaper copy. Personally, I can't see why advertising material should be kept out of the monthly bills if you really want appliances sold.

5. If the central stations want to sell appliances why not let them be sold out of their district offices on a concession basis as the central station is best equipped to handle the collection problem.

I believe to give any real impetus to the sale of washing machines, the power companies will have to select several makes of washers to sell or help sell. There are 120 makes, some better than others and they can't help them all. As a matter of fact, they have already done that on ranges, heaters and electric refrigerators. Requirements as to quality, distribution, price, washing ability, service, delivery, upkeep, costs, etc., could be the basis of selection. Grief in doing so, yes, but necessary to get any real volume.

The washing machine as manufactured at present represents practically no load compared with several other appliances, but is a real asset to the housewife and a stepping stone to the inception of the electrical idea. But the washing machine of the future may be a real load-building device. We conducted a survey of 1,000 users of our particular washer, which is equipped with a gas water heater, to find out their buying motive for our particular make. Thirty-seven per cent of the replies stated that the water heater was their primary buying motive. The gas companies in other sections have sold many thousands of washers on account of this gas heater. It appeals to the housewife.

A washing machine with an electric heater of 1,000 watts to maintain the temperature or a 4,500-watt heater to heat the water in the tub is both feasible and desirable from a sales and load standpoint.

The appliances sales problem in California has taken an inevitable trend under present circumstances to the detriment of many interested factors in the appliance business. I believe the power companies can materially improve conditions and assist the electrical dealer by actively aiding the sale of lamp socket devices at regular retail prices.

Unified Merchandising

By GEOGE W. BARKER

For the first time in the history of this organization this committee, heretofore known as the "Appliance Committee," has functioned, at the request of the National Electric Light Association, as the "Merchandising Committee." For the sake of uniformity and unanimity the committee gladly adopted the new nomenclature, thereby definitely establishing the proper committee designation for the future. Although working under a new name the committee has not felt that the scope of its activities was in any way changed and has centered attention on matters pertaining to electrical appliance sales.

At a formal meeting of this committee held in San Francisco in December, 1925, the following resolution was passed: "Let it be resolved, that the sense of this meeting is that this committee should recommend for practical application a feasible plan for the constructive development of retail electrical appliance selling; that this plan, in turn, be transmitted to the chairman of the Commercial Section of the Pacific Coast Electrical Association for his consideration; that, in the event of his approval of the plan, he be requested to transmit it to the Executive Committee of the California Electrical Bureau for their consideration, with the idea in mind that, if their directors approve, this committee shall take the necessary steps to have the plan become operative."

Therefore as a part of this committee's general program to advance ideas, suggestions and methods that might be helpful in electrical appliance merchandising, a great deal of thought and attention has been given to the matter of definite and concrete selling plans. The general opinion that "there is nothing new in merchandising" does not seem to be borne out in fact. However, this committee has been more concerned with drawing anew attention to proved methods than with seeking acclaim for propounding untried ideas of possibly doubtful value. Therefore, every suggestion has had the most careful scrutiny by the practical merchandisers who compose the committee and frank discussion has been held on every phase of selling activity that has been presented. The experiences of all classes of electrical appliance retailers have been carefully reviewed and analyzed with the intent of incorporating into a general plan any good that might have been noted. From these discussions one thing has become very evident—the need of united and directed selling effort. As a result of its studies and conclusions this committee feels that the plan herewith presented and which has already been forwarded in accordance with the resolution above mentioned is worthy of more than casual attention on the part of all concerned with appliance sales.

Some time ago a plan that embraced much that was new in sales application was advanced informally by a member of the committee. For reasons not necessary to expound here the plan has never been put into effect within the territory of this association. It has, however, been presented in a trade journal and has induced much favorable comment and is now being worked out on a limited scale in the East. The committee feels that this plan points a way to greater appliance sales, that it justifies committee endorsement, and constitutes a valuable contribution to merchandising practice.

Briefly, the plan provides for unified selling; that is

to say, the featuring for sale of the same device at the same time by all retail outlets. By the term "all retail outlets" is meant all dealers who sell electrical appliances at retail, no matter what may be the general nature of their business. It is the intent of this plan to bring about a unity of thought and action with regard to appliance selling that has never before been conceived and that, in practice, has never been attempted.

It is the feeling of the committee that such a plan as this will serve to draw closely together all of the merchandising interests in electrical appliance selling activity. This should result in a better understanding of matters electrical by the non-electrical outlets, resulting in more intelligent appliance selling, and should serve to bring to the electrical outlets the merchandising practice and experience of other lines of trade. It is the feeling that such interchange will, beyond question, result in increased appliance sales. The regrettable falling off in appliance penetration—from 25 per cent in 1920 to 20 per cent in 1923—certainly gives sufficient evidence of the need of some plan that will turn the tide of diminishing sales per capita. If dealers are to maintain their just volume of appliance sales, if power companies are to continue building an appliance load that is attractive in earning power, and if manufacturers of electrical appliances are to retain their position in the field of competition with fuel heated devices, then some sort of concerted action is immediately necessary.

In formulating a plan for merchandise sales promotion, this committee has endeavored to keep away from complexities and to make its suggestions along as simple lines as circumstances warranted. It has been the committee's desire to present a definite working and workable outline applicable to the sale of all domestic appliances while at the same time taking cognizance of all such devices that are now, or that should be, of common application in the home. The plan proposed was original at the time of its initiation but has since been advanced by the National Electric Light Association. That organization, however, has not yet applied the plan on such a broad basis as is contemplated by this committee. Perhaps this is on the theory that the plan should first be tried out in part before being more extensively applied. It is not the desire or intent of this committee to detract from the work of the National Electric Light Association or of others who have made progressive moves. On the contrary, this committee wishes herewith to express its appreciation of these forward moves and to present its desires to co-operate in whatsoever movement may be found to be for the greatest good of the electrical appliance merchandising. However, conditions within the territory of the Pacific Coast Electrical Association seem to justify greater activity in appliance sales development than that proposed by the National Associaion plan. For that reason this committee has continued with the formulation of its plan.

Under this plan the administrative organization will schedule for an entire year the appliances to be featured and will advise all interested branches of the industry—as well as interested related industries—as to the program, or sales calendar, sufficiently in advance to permit of the fullest advantage being taken by all. It is intended for the sales calendar to cover a twelve-month period, those devices being selected for any one month that are seasonal to that month or that experience and local conditions have shown to be most readily saleable at the calendar schedule period. This, of course, means that the plan will be semi-flexible in application—as regards merchandise selected for special effort—and means, further, that full consideration has been given to all factors in the preparation of the suggested schedule.

It is intended that the administrative organization prepare proper displays and advertising material, arrange with dealers and others for the use of prepared material, assist dealers in window trimming and the preparation of newspaper advertisements and secure the co-operation of all factions interested in the promotion of electrical appliance sales. It is fortunate that there is at hand such a well-organized and well-directed machinery as that of the California Electrical Bureau. With its intimate contact with all classes and kinds of retail outlets and with its recognized non-partisan position in the field it offers an ideal medium for putting into practical application the recommendations of this committee.

Inasmuch as the sales calendar will be prepared for one year in advance it will be an easy matter to disseminate information concerning the seasonal activities and it will also be easy to prepare suitable publicity well in advance of its use. This publicity need not be confined to advertising material but can as well include reading notices and other propoganda, addresses for presentation before women's organizations, civic clubs, luncheon associations and other similar bodies. The field employees of the Bureau can do excellent work in this regard.

Believing that intensive activity for a relatively short period is better than general effort for a longer time this committee has deemed it wise to formulate a program covering the first week of each month. Of course, any dealer may continue the featuring of any device for as long a time as he desires or as circumstances warrant. In the main, however, it is the committee's thought that a close following of the plan will work to the best advantage of all interested.

In formulating the following schedule due recognition has been given to all the factors of electrical appliance merchandising. Seasonal demand, climatic conditions and the psychology of buying have all been taken into consideration. The resultant sales calendar, therefore, represents in the judgment of the committee the best outline for appliance sales activity in any one year within the territory of the Pacific Coast Electrical Association. It seems desirable that as few as possible departures be made from the proposed schedule.

Electrical Appliance Sales Calendar

January—Toasters.

February—Waffle irons (extensive annual effort by one Western power company has proved this to be a splendid item for this month).

March—Vacuum cleaners (on account of the approach of the annual "spring cleaning.").

April—Ranges and percolators (in anticipation of the heat of summer).

May—Refrigeration and table stoves (on account of the climatic conditions prevailing generally at this time).

June—All appliances all the month.

July—Fans and kitchen ventilators.

August—Flat irons and toasters.

September—Washers, wavers, curlers and small appliances. (The vacation period is about over and beauty appliances are in demand.)

October—Ranges, stand and table lamps. (New homes have been completed and the long nights are at hand.)

November—Electric air and water heating week.

December—All appliances all the month.

This schedule, while particularly adapted to the territory of the Pacific Coast Electrical Association, may, perhaps, well be modified to conform to any similar national movement in order to take advantage of national publicity.

It will be noted that for the months of June and December the committee schedules "all appliances all the month." On account of the June Bride movement—which was originated by the predecessor of the present California Elecrtical Bureau, and which has for several years been eminently successful—June is a particularly good time for electrical appliance sales. December, of course, presents the annual gift-buying season with its attendant enormous appliance sales opportunities.

The advantages of this plan are far too many to incorporate into a report such as this. Suffice it to say that manufacturers may better regulate their production, jobbers may more intelligently assemble their stocks and dealers may more efficiently handle their buying. This should result in increased turnovers for all selling outlets with corresponding favorable effect on net return, and should also produce lessened inventories. The practical application of the plan, too, establishes a continuity of thought as regards appli-

ance purchases by the consumer that is not now possible. The sales effect of concerted display of one appliance cannot but be written in increased volume. As it is now, a prospect's attention is first on one device and then on another. His thoughts have not the opportunity to focus on the desirability of any one appliance.

Co-operative advertising—where, for example, full pages are taken in the newspapers and the space divided up among several dealers—will be much more forceful and will command much greater attention than the average small space used by an individual dealer. Letter inserts, circular letters, window displays, wagon banners and all forms of advertising should feature the device scheduled at that time. The make of equipment sold does not enter at all into this phase of the plan. The big thing is to sell the idea of using the particular electrical appliance that is being advertised. It is distinctly the retailer's function to convince the prospect that the particular make of appliance he is offering for sale is superior to others.

Dealers should be brought to a realization of the fact that a large part of the good that will come to them from the plan lies in the unanimity of action. For that reason all dealers should be urged to put forth great effort, during the first week of each month, to make adequate display, both in their stores and windows, of the electrical appliance scheduled on the sales calendar for that particular period. The effect on the buying public will be, beyond doubt, such that greatly increased sales of the article displayed will result.

It is very strongly the committee's thought that matters have drifted long enough. It is now time for the entire industry to get behind some such plan as is herewith proposed and to see to it that the plan is made fully effective. In no other way can the committee see relief from the present condition of falling per capita sales.

Remarkable Growth of the Ironer Business

By J. W. FERRY

Why has only one ironer been sold to twenty washers?

According to statistics on washer and ironer sales presented in January, 1926, issue of Electrical Merchandising, there are 219,000 ironers and 4,363,000 washers now in use in this country.

Of the 219,000 ironers, over 55,000 of them were sold last year. This means that in one single year better than 25 per cent of the total ironers now in use were put into the homes of the American public. Why such a remarkable growth in the past year?

It is easy to visualize that some very important developments must have taken place. That is true because in the year just past ironers have been put on the market incorporating improvements in design so as to make them practical for use in the average home.

Heretofore most all ironers were large cumbersome pieces of machinery requiring a great deal of floor space and presenting themselves as a commercial proposition and not a machine designed for the home. They were so large and bulky that the basement, or a specially designed laundry room, was the only place that would accommodate them.

This feature alone probably set up the greatest resistance to the sale of ironers. Inherently, ironing as compared with washing is a clean job and the housewife wants to do it in clean and attractive surroundings, which condition does not usually exist in the laundry or basement, and she did not want to buy another appliance that would keep her in the basement any longer than necessary. After finishing her ironing she wanted to get upstairs again as soon as possible. She would much rather do the ironing in the kitchen by hand, even though it required much more time and greater physical effort. This was probably the greatest resistance to ironer sales, but there were other contributing factors. For instance, ironers were commonly known as mangles—even the word itself set up a resistance in her mind, in that it conveyed the thought of tearing or pulling, and they were commonly spoken of as flat work ironers and not capable of doing the more difficult pieces such as men's shirts, house dresses, children's clothes, underwear, etc.

Both of these major objections, and a great many minor ones, are now overcome with the new machines which have been placed on the market in the past two years. And the ironer manufacturers recognize the importance of re-selling the public on the ironer idea and are spending a great deal of money for advertising in national magazines and trade papers.

That the job is being well done, is shown by the figures quoted—that 25 per cent of all the ironers now in use were placed in the homes last year.

As there was such a small amount of interest displayed by the buying public, very little, if any, was displayed on the part of the appliance dealer. It is true that dealers as a rule carried an ironer on their floor, but it was looked upon as "an orphan." The dealer and his organization knew little or nothing of the business, or of the ironer he was attempting to sell, and the manufacturer with such limited sales probably did not think it worth while to spend his time and money educating the dealer.

However, this discouraging picture is entirely effaced and now the industry has had presented to it in the new ironer what promises to be one of the most profitable and biggest labor saving appliances for the home.

Everywhere you hear the new ironers talked about and discussed. The trade is becoming thoroughly alive to the possibilities, and the dealer and his organization are becoming more and more sold on the idea that before long the ironer will be just as important an item with him as the washing machine is at the present time.

Not long ago, one of the manufacturers who has been making washers and ironers for a long time, made a survey among users of both machines with the idea of finding out which appliance was considered by the housewife to be the more desirable. Ninety-five per cent of those who replied said that if one or the other had to be given up, the washer would be the first to go. In other words, the ironer was prized more highly as a time and labor saver than the washer. And mind you, these people were using the old type ironer.

In addition to building a machine that can be used in the kitchen, that's pleasing to look at, convenient to use, that will do all the ironing (instead of only part of it), the manufacturers have designed machines incorporating other noteworthy improvements, chief among which is the "full open end" which permits skirts and other tubular articles being placed over the full length of the roll. This feature adds greatly to the utility of the machine, and with very little practice the operator can iron practically everything in the average family wash.

Then there is the automatic control which eliminates the use of foot pedals, or hand levers of any kind, and makes it possible to operate the machine with no physical effort. The operator sits at the ironer and guides the pieces through.

Among washing machine manufacturers it has long been recognized that a great many machines after being sold are used only for a short period of time, then put away—forgotten about, and the work again goes out to the public laundry. No worse condition can exist because it undoes all the work that was necessary to make the sale, and one unused machine discourages the sale of many more. This condition is becoming quite prevalent and is due entirely to the fact that in selling the washer alone the hardest part of the job—the ironing—was left to the housewife to be done by hand, and as a consequence the value of the washing machine in thousands of homes was being discounted every week. Now an ironer in those homes will put the washer in use again and instead of a disinterested washer user, the dealer will have an enthusiastic booster for both.

The size of the market for ironer sales was pointed out in the second paragraph, and it is fundamental that the biggest majority of ironers will be sold in homes where washers are used. That is logical, because the idea of doing the laundry at home by ma-

chine has been thoroughly sold, and the woman who has been educated that far is easy to interest in the proposition that she should have an ironer to complete the laundry job.

It is not hard for the dealer to visualize his local market. He knows how many washing machines are in use in his community and he knows where a great many of them are. If he will direct his ironer selling propaganda into that channel his efforts are bound to meet with immediate response, and his reward will be measured by the amount of effort he puts behind it.

Then there is still another market, although not as lucrative, nevertheless important, and that is the customers of the "wet wash" and "rough dry" laundries. Principally in the larger cities the wet wash and rough dry laundries have grown to institutions of immense proportions. Thousands and thousands of people patronize them. The work is returned to the home unironed and the housewife does it by hand. In selling this class the dealer will have the co-operation of the laundries, as it is a protection to their business to have an easier way to do the ironing at home and insuring the continuance of the housewife's patronage.

It is generally known that the wet wash laundry will wash a bundle for 85 cents that would cost $3.40 in a finished laundry. In other words, the cost of washing is only ¼ the cost of the complete job. The housewife who patronizes the wet wash recognizes the large saving by doing the expensive part of the job at home, and a person of such an economical turn of mind can easily be made to see the wisdom of investing for a short time the money she saves, in an ironer.

The job of selling ironers has been found not to be as difficult as was generally supposed, but a definite plan is necessary, and just as hard work and well-directed effort is essential as on any of the other major appliances. It is easier than washing machine selling was ten years ago, because the washing machine man has laid the ground work.

As pointed out before, the dealer should recognize the fact that primarily his market will be among washing machine users, and first of all many of those people whom he sold himself; he has entree there and will find his own customers most easy to approach.

The first step in ironing machine selling is to get the ironer into the home and the most effective way to do that is by personal call, and the call should be made with an ironer on the truck and ready to demonstrate. Ironers placed in the home in this manner will stand more "high pressure" selling than most other appliances. Demonstrations can be "forced" because the possibility of a "pull" is not as great as in other appliances, and even though it is not sold, the ironer can be cleaned and polished, and paint scratches touched up and put back in stock and sold as new. From the dealer's standpoint, this ease of reconditioning is important, because as compared with the washing machine it is not necessary to reduce the price $10 or $15 and sell it as a demonstrator.

After permission has been secured for the demonstration the salesman should go through with the entire program even to the close; some dealers have one person secure the demonstration and another one try for the "close." In actual practice we have found that better results are secured when the housewife deals only with one "personality."

The first step in the demonstration is to thoroughly acquaint the prospective purchaser with the operation of the ironer. Then the salesman should seat himself, iron a few pieces of flat work such as a pillow slip, towel and bed sheet. Run these through, calling the housewife's attention to the ease and simplicity of the operation; then ask for a napkin—iron it carefully—do not fold it, but call attention to its straight edges. Then hand it to the prospective purchaser so that she may observe the high quality, lu·ter and finish. Next ask for a tablecloth. Permit the cloth to advance over the roll 10 or 18 in., then ask the customer to take hold of the two outer edges of the cloth, and the moment she does, the salesman should step to the left and push the chair forward so that the housewife may be seated. From here on it is the salesman's duty to wait upon her—handing her one piece after another and instructing and aiding her in the correct handling of each piece to be ironed.

By this method the prospective purchaser is educated and it does away with the old practice of a professional demonstrator doing the entire job. It has been found that more ironers can be sold by this method and at less expense, as the prospective purchaser actually does the work herself and is convinced that after a little practice she will become capable of ironing everything in her laundry.

Dealers can depend on the ironer manufacturer to give them a great deal of help and assistance if they will get in touch with the manufacturer whose ironer they are selling. Every one of them is anxious to help and the dealer should not hesitate to take advantage of every bit of assistance offered because now is the time when the dealer should get behind this appliance which in another two or three years is about to be as popular and as big a seller as the washing machine has been for the past five years.

Deferred Payment Merchandising

By P. H. BOOTH

In the problem of marketing merchandise there seems to be no question but what the system of manufacturing and distributing commodities which prevailed up to a few years ago is undergoing a decided change. As is customary when all changes occur in the generally established fundamentals of manufacturing and distributing commodities, these changes are often overdone, but eventually the pendulum swings back and a normal improved condition prevails. This, in reality, is what we are going through today in the general business of manufacturing and distributing merchandise.

The changes which have been incorporated into the former methods of manufacturing and distribution are what is known as the deferred payments system, which is another progressive method of distribution. Some choose to call it the "mortgaging income system." It is an old plan for pianos and sewing machines, but it is new to general business, largely because of the use of a third party incorporated between manufacturer and distributor in the function of finance companies. These finance companies take the paper from the dealer and perform the banking portion of the financial transaction. It makes an easy matter for the dealer to finance deferred payments of his customers, and it has worked so smoothly and so effectively and the incomes of producers have been mortgaged for six, nine, twelve and eighteen months in the future to such an extent that it has increased business considerably during the past few years over the increase which we would normally have had under the old system of so-called "cash and carry" or terms of half cash, balance in thirty to sixty days.

This new standard of manufacturing and distributing merchandise is expanding at a rapid pace, and accordingly brings up many arrangements pro and con by the "calamity howlers" and the optimists, and even by the conservatives and the progressives, so that there is a great deal of serious consideration being applied to this new question of deferred payments in marketing merchandise.

Advantages of Deferred Payment Plan

There seems to be no quesaion but what this deferred payment system has many advantages, and its disadvantages overcome its objectionable features so far as we can judge by experience to date. One of the particular advantages is that it makes it possible for the American standard of living to be elevated much higher than it could possibly be without the deferred payment system. You can now buy clothes and many other commodities used at home, with the possible exception of groceries and drugs, gas and electricity, or commodities that are immediately consumed when purchased, with the result that the purchasing power of the average home is thereby extended to other devices which the homes of the country have not previously been able to buy. For instance, by being able to buy a pair of shoes or a suit of clothes and not have to pay cash, but only 25 per cent down, it is possible to use that additional cash to spread out over the purchase of a radio, a

range, washing machine, ironer, more and better clothes, furniture, vacuum cleaner, art works, etc., many of which would not be in the homes today if it were not for the deferred payment system of marketing.

It is true that the service rendered the consumer by this deferred payment plan naturally costs the consumer money, because no service rendered can possibly be rendered without cost, but the consumer elects to pay this additional cost in order to increase his purchasing power. It is just as though a business firm uses a bank for loans and pays for the privilege. In like manner a consumer uses a finance company for loans and pays for the privilege.

Another advantage which this principle of deferred payments gives is the fact that sellers must have confidence in the goods they sell if they are to give extended payments to the consumer, even though these extended payments are handled by finance companies, as the dealer has the responsibility eventually to the finance company for the money and to the consumer for the merchandise. The result is that merchandise sold on extended payments is higher grade merchandise than the consumer would purchase by the old standard.

Another decided advantage from the consumer's angle is the fact that deferred payments teach thrift. The American public is intrinsically honest, and they respect their obligations most seriously and most deliberately. When they obligate themselves to carry out a deferred payment contract the percentage of returned goods or defaulted contracts is comparatively small. This deferred payment plan has given rise to a very popular expression in the home, "We only have one life to live, let's enjoy it," and the large increase in the automobile business during the last five years has been largely attributed to that one phrase, and that one phrase, coupled with the easy payment, or deferred payment system, has unquestionably increased the pleasure of living in millions of homes in the United States. It is interesting to note also that the United States is practically the only country where this syshtem of deferred payments is in effect to any perceptible degree as an integral part of the general manufacturing and distributing schedule.

The increased buying power of the consumer, with its resultant expanded market for consumer purchases, does not mean that the consumer will buy luxuries as such in excess of the restrictions of good business. The opponents of the deferred payment system have steadfastly maintained that the money or the income possessed by individuals has been trifled away on commodities, real estate and merchandise in general, which the consumer has no logical reason for purchasing, with the result that their income is mortgaged and they are deprived of the essentials which they need in a well conducted home. As an example of this, we quote from an editorial by J. H. Tregoe, executive manager of the National Association of Credit Men, who says:

"This is my monthly installment on the car," said the woman to the accountancy department of an automobile dealer, "and this is how I obtained it." By the side of the money she laid down a pawn ticket. Some jewel had been pledged for the money to make the monthly payment.

"This is the engagement ring," thought the prospective benedict, "and it will all be paid for in a year." "Ah!" thought the seller of the ring with a chuckle, "if I secure three monthly installments—and take back the ring—the transaction will have paid a profit."

These are not overdrawn incidents. They are happening all the time; and I am wondering what the economic, aside from the moral effects might be. Proponents of the installment plan of selling claim that it is not hurtful because the cost burden of the risk and the time are borne by the buyer.

If, to satisfy a need or a desire, an article is bought on installment payments covering six or twelve months, does the plan in the long run increase production? Does it not by the additional costs for the risk and time reduce ultimate consumption?

Is it not possible also—by diverting too large a share of future income to the redemption of installment obligations—to cut off the buying of normal comforts and thus to throw general business out of balance?

Production in order to assure even and stable business must have an eye to economy. There should be a control of costs that will neither affect the buying power of consumers nor make prices unattractive.

In my opinion the installment plan of selling does not lend itself at all to some commodities. The further it is indulged the more difficult will our economic problems prove to be. Merely selling goods without some idea of the consumer's ability —without an eye to the future so as to keep distribution at least fairly even—is not a wise process. And yet such selling occurs in some lines these days.

If through the savings of eight months I can buy an article that would take me twelve months to pay for on the installment plan, then I have not been entirely wise in the purchase—unless there were very strong reasons for me to pay the additional costs and to decrease my ability to buy other things.

In reply to the above article, a reputable clothier in Los Angeles states:

Clothing is a necessity; more than that, clothes are compulsory. One must have clothing, whether one wants it or not, or whether one can afford it or not. Second: Self-preservation is the strongest instinct in man, and clothing is man's only way of protecting himself against the elements. Third: The world formulates its first opinion through the impression made by the appearance of an object. We cannot stop to investigate the qualities, good or bad; the usefulness; the desirability or the reason why of everything our eyes take in. The very idea is ridiculous. It would be more than impossible. So you see that it's mighty important for appearances to give the right impression.

People admit the importance of good clothes, yet whenever they are in tight financial conditions they are tempted to make "last year's hat," "that old suit or dress," "that old coat even if it is a little out of style," do. They haven't enough extra money to buy something new. But a "credit account" does away with this. They "can afford" to be well dressed at all times, to make a good impression, to get more out of life and to still save and get ahead.

The above is a fair example of some of the pros and cons encountered in the many discussions in every line of business, and yet this new third power in the distribution of commodities goes steadily ahead with ever-increasing expansion, and the more the deferred payment plan progresses, the more business increases and the more expansion continues. This naturally brings up the point as to how far this expansion, financed by finance companies, can go, and can the finance companies stand the test of any general business reverse which will in general curtail the income of the consumer? We have the answer to this problem in a small way in the recent anthracite coal strike, centered around Scranton, Pa., and the merchants of Scranton and the finance companies holding contracts in Scranton declared a moratorium on deferred payments for the period of the strike and immediately went on a cash basis. That was an individual case, no harm was apparently done, and the finance companies were able to handle the moratorium without serious inconvenience.

The question, however, is continually raised as to how far these finance companies can go in this continued expansion of trade, due to the deferred payment plan, before the pendulum starts to swing the other way and the reverse in general begins to accumulate. In the automobile industry, for instance, they are experiencing today a condition where the weak finance companies in the auto trade are going out of business, and the strong companies are getting stronger, indicating more than ever that the deferred payment plan is a new economic method of doing business. But we must always be confronted with the question of what is the measure of the right of the individual to buy under the American standard of living, and the judgment in the handling of this new element in business will be the judgment exercised in determining the proper limit of the individual in time payment purchases.

Experience of Electrical Industry

With this fundamental discussion of the high spots of time payment merchandising, what is the experience of our own industry in its use over a period of years for the sale of electrical merchandise? The Washington Water Power Company, Spokane, Wash., sells commodities such as an electric range and a water heater installed for $220, with a $10 down payment, and the balance $10 a month with a discount of 10 per cent for cash. These deferred payments are extended to customers on their lines with whom they are in contact right along, so that their credit department has a fairly accurate picture of a customer's habits of paying and can, accordingly, exercise good judgment in passing upon orders placed under the above proposition. This is an example of the time payments which are extended in other lines of merchandise by the above company. By these sales 75 per cent of the annual sales of the company in merchandising are made and these annual sales total many hundreds of thousands of dollars over a period of years and losses have been

practically negligible. Lewis A. Lewis, the sales ment plan of selling electric ranges, and though all credit men seem to be looking forward to a collapse of our present installment method of purchasing, I cannot help but feel that our increased sales during the present prosperous times will far out-balance any losses that will be incurred should any depression come."

Another central station, the Northwestern Electric Company in Portland, has established an installment sales plan on the basis of 10 per cent down, 5 per cent per month, making the limit of their contracts work out in eighteen months, and any appliance they handle can be bought on this basis. Losses on time payments over a period of years have totalled somewhat less than 1 per cent, and defaults on conditional sales contracts not more than 2 per cent or 3 per cent per year. The cost of installation is included in the time payment on devices such as ranges and water heaters and heavy duty apparatus, although the invoice is paid by the central station to the contractor-dealer making the installation. In commenting on the question of time payments, J. C. Plankinton, sales manager, has this to say:

"I very much fear that the present trend toward extending this deferred payment plan to include jewelry, clothing, etc., is that the wage earner will be so burdened with monthly payments for luxuries, etc., that he will, in time, be unable to meet his obligations So many people cannot refuse a salesman's solicitation as long as easy payments are offered. If the American people were required to liquidate on short notice, there would be a very great calamity resulting."

The Utah Power & Light Company in Salt Lake City has used the deferred payment plan for its merchandising for a number of years, but it requires no exact percentage as a down payment. The amount is varied to suit different sales activities, and may be as low as $1 down to as high as 10 per cent of the purchase price. It uses the retail cash price and adds one-ninth to this amount, so that, when discounting 10 per cent for cash the net equals the retail list price, and the purchaser may even receive at any time a 10 per cent discount on the balance unpaid, by paying the amount in full. The maximum amount of time allowed is twenty-four months. Merchandise losses have been very small on deferred payment contracts. An allowance is set up in the company's cost accounting of 0.5 per cent of the gross billing to cover losses of bad accounts. This is usually in excess of the actual losses. In commenting upon this feature, P. M. Parry, commercial manager, says:

"We work largely on the theory that practically everyone is honest, and while we have to take back merchandise occasionally, it is usually resold at a price which is sufficient to cover the cost of re-handling and cover the balance due from the previous owner.

"The installation price is included in the purchase price of ranges, water heaters and heavy duty equipment wherever this is desired on the part of the customer, and the cost is distributed over the period allowed for the purchasing of the equipment. All wiring is done by outside contractors and dealers. Our idea in securing a small down payment has been largely to make it easy for the customer to secure delivery of the equipment, and thus remove as much sales resistance as possible. We feel that the down payment is not a material item, except that it shows evidence of good faith and responsibliity, but as far as actual credit rating is concerned, we do not believe it makes any difference in connection with the purchase of a range or other appliance whether the consumer pays $1 down or $15 down. The time payment plan is, of course, an inducement for most people to buy a much more expensive and higher grade appliance than would be the case if they had to pay for same in a comparatively short time. It is my opinion that to get a proper consumer acceptance of the newer electrical appliances, especially those costing a considerable amount of money, such as ranges, water heaters, heavy duty equipment, refrigerators, etc., the time payment plan must be resorted to for the same reason that the consumer as a rule is not accustomed to paying the price required for the purchase, and the time payment plan also gives the consumer the evidence of our confidence in the practicability, the utility and the lasting qualities of the merchandise that is being offered for sale."

With the Puget Sound Power & Light Company, Seattle Wash., the down payment bears no definite relation to the selling price. Ranges, washers, ironing machines, vacuum cleaners, and refrigerators are all sold on the time payment plan, subject to the approval of the credit department. The actual defaults are very small. The installation cost on ranges and water heaters is included in the price of the time contract.

With the Light Department of the City of Seattle, the regular time sales plan is on the basis of 25 per cent down and the balance in one year, but on special campaigns terms are extended for a longer period, occasionally as long as eighteen months; 5 per cent is added to the cash price for time price. Appliances which can be purchased under the time payment plan are ranges, water heaters, large air heaters, washing machines, ironing machines and vacuum cleaners. All sales are made subject to the confirmation of the records in the office, showing the customer is one of the regular consumers of current and entitled to deferred payment credit. Financial losses are less than 1/10 of 1 per cent, and less than 3 per cent default in their contracts. Installation price is included in the time contracts.

With the Idaho Power Company, the down payment is 15 per cent, 10 per cent discount for cash, and fourteen months is the length of their time contracts. Losses are ¼ of 1 per cent. Installation price is not included in the time payment price on ranges and water heaters, as customers either pay their contractor-dealer or the central station takes over the contract and carries it over a period of months. In commenting upon this time payment plan, J. F. Orr, sales manager, states:

"If you sell good serviceable merchandise and make payments easy, your customers can make them. If the payments are too large, they cannot meet them—of course a sufficient amount must be added to the cost to take care of thec arrying charges for the deferred payments."

With the Pacific Power & Light Company a down payment, except for campaigns, is 10 per cent of the contract, but on special campaigns a lower down paymen has been the inducement to purchase. All appliances above $50 list are especially priced for time payments, and a discount of 10 per cent is allowed for cash payment, but on ranges only a 5 per cent discount is allowed. The length of the time contracts is eighteen months on the larger appliances. All appliances are sold on time payments from flat irons to ranges, all subject to the approval of the credit department, or in the branch districts, the district manager approves the credit based upon the books of the company and information secured through the retail merchandise credit association. An amount of ½ of 1 per cent is set up as a fund to take care of losses, and this much more than covers the expense of the losses sustained. Installation cost is included in the price of ranges and water heaters, the contractor billing the company for the installation and the company adding its percentage to the amount of the cost, and putting this amount in the time payment contract of the customers.

During the year 1925 69 per cent of the company's gross business was contract business, and during 1924 the same percentage of contract sales prevailed. In commenting upon this, Vernon H. Moon, appliance sales manager, states:

"On appliances such as ranges, washers, vacuum cleaners, etc., the percentage would even run higher than 69 per cent, and, furthermore, there is no question but what so-called easy terms stimulate volume. Practically every large appliance which we sell has a life a great deal in excess of the period of the contract. This is ample protection for the seller, particularly where some attention is given to the credit risk before the sale is made, and it establishes the confidence of the purchaser in the merchandise being bought. We always make a special effort with our district managers to use particular care to see tnat the first few payments on a contract are collected, and if this is done, we receive a sufficient amount to

reimburse us for any possible expense or loss should the article be returned."

It is easily seen that the above figures, which in general apply to the electrical business as a whole whether conducted by retail dealers or central stations, and our investigation of the department store trade so far as it refers to electrical appliances, confirm the general estimate of down payments, credit losses and returned merchandise because of defaultd contracts. The only exception is the question of terms, and the retail merchandise, possibly due to the restrictions of the finance companies, which usually limit contracts to ten or twelve months, whereas in the above mentioned instances, the central stations usually carry their own time payments, and the amount added to the contract covers the expense.

In this article an effort has been made to touch upon the high spots of the time payment principle in general and its application in a larger way to our electrical business in the hope that it will not only encourage time payment merchandising on an extensive and aggressive scale, but it will also encourage caution and care in the judgment that is used in handling this latest and most modern and improved addition to our economic methods of doing business.

Value of Electric Refrigeration to the Individual

By R. T. STEPHENS

Refrigeration as a means of preserving food dates back to the time of the Roman Emperors, who used mountain passes filled with snow to store the perishable supplies of their armies. Even after that, the ancients recognized that sun-dried foods also saved their lives. It was from these two ancient methods of food preservation that gradually has been developed the preservation of foods by dry cold.

Refrigeration was obtained in India at a very early date by the rapid evaporation of water, but it was not until 1755 that Dr. Cullen placed in operation the first ice machine to manufacture ice. He accomplished the feat by using the principle of the evaporation of water under vacuum. At about the same time Savoisier operated a machine by utilizing the evaporation of ether. In 1824 Vallance patented a machine operating on the evaporation system as practiced in India.

It was not until 1834 that a really successful machine was perfected, and that by a man named Perkins of London. This was rapidly followed by other systems and developments, until today we have a multitude of highly perfected machines.

The first successful machine for the home was the Frostmaker, which was made in Chicago and placed on the market about 1908. From 1908 until 1923, 30,000 homes in the United States were using electrical refrigeration. The use of these machines since then has grown by leaps and bounds, until on Jan. 1, 1926, according to the Refrigeration Committee of the N.E.L.A., approximately 70,000 domestic machines were in successful operation. Each succeeding year is bound to see electrical refrigeration grow consistently.

A practical means of food preservation, the necessity of which was recognized even by the ancients, is today within the grasp of every home owner in the United States. Today we have at our disposal and for our use a machine which might be included in a list of the seven wonders of the modern world.

A Modern Wonder

Several years ago an international questionnaire was sent to hundreds of learned men in every type of profession. In it they were to state what seven things or processes of today they would include in a list of the seven modern wonders of the world. One of the processes given a majority mention was that developed by the great Pasteur. The name given to the process is common to every tongue today for pasteurization is depended upon by the millions of people inhabiting the earth. The process is one to prevent germ growth in milk and to keep the bacteria content at a safe point to make it fit for human consumption. Such a life preserving process was named to the world as one of its seven modern wonders.

Today, along with the many other modern wonders, we do not hesitate to say that a process or a machine which preserves life and prevents disease should rightfully continue to be included in a list of present-day wonders. The modern electric refrigerator is deserving of a place and could rightfully be included as one of the seven wonders of the modern world, if for no other reason than that it is a processing machine to preserve life and guarantee continued health to its users through refrigeration.

For the purpose of going into the matter more thoroughly, however, this paper will develop the four outstanding values of electrical refrigeration to the public today. These well may be classified as follows:

First—Health.
Second—Convenience.
Third—Pride of ownership.
Fourth—Economy.

Health

First consideration will be given to the value of electrical refrigeration to one's health. Follow, if you will, the work of the great Pasteur. If no means were taken after milk were pasteurized to further prevent bacteria growth, milk would soon spoil, for it has been proved that when milk is kept at a temperature of 50 deg. or lower, the bacteria increase very slowly and there is little likelihood of harm coming from the consumption of the milk. It has also been proved, and is an accepted fact that at higher temperatures they grow at an ever increasing rate. Tests taken at the University Farm at Davis, Calif., showed the following:

Milk at 68 deg. had at the end of 24 hours, 6,000 times more bacteria than it had at the beginning; and after an additional 24 hours, had 300,000 times more.

The following is taken from the U.S. Department of Agriculture, Farmers Bulletin No. 490:

Rate of Growth of Bacteria in Milk—Relative Number of Bacteria
(in multiples of original number)

Milk Held at	After 6 Hrs.	After 12 Hrs.	After 24 Hrs.	After 48 Hrs.
50 deg.	1.2	1.5	4.1	6.2
68 deg.	1.7	24.2	6128	357,499

These conditions are common to all perishable foods. Although the growth may not be as active in all cases, yet recomposition and decay goes on just the same. Under 32 deg. many food products undergo a decomposition which causes them to decay slowly, since practically all such foods contain water, which upon freezing, breaks down the tissues and decay commences.

To preserve foods then, and to prevent bacteria growth, a safe range in temperatures is necessary in the box in which are stored perishable foods. This range has been determined to be between the freezing point and 50 deg. Such temperature ranges are obtainable today only by the use of the modern electrical refrigerator, the user of which is assured of a crisp dry cold which prevents germ growth, which in turn reduces the possibility of food spoilage and subsequent illness.

Added to this feature of the modern electrical refrigerator is the provision of an immaculately clean, white enamel interior in the refrigerator itself. This also insures that appetizing and healthful foods may be kept safely for it eliminates all the dirt and moisture which results from any other form of cooling. It is impossible to determine the value of such a service in dollars and cents. These safeguards to health make electrical refrigeration a hygenic necessity.

Convenience

We will pass on now to the convenience of an electrical refrigerator, which is the second feature enjoyed by the owner of such a machine. Once installed, due to the automatic devices that are a part of all successful refrigerating machines today, little or no attention is needed for its continuous operation. All the dirt and labor involved in other forms of cooling are forgotten. Beyond an occasional service call for repairs, no attention to these machines on the part of the user is necessary. Savings in labor and trouble through the use of electrical refrigeration more than justify the original investment. The monthly operation costs are soon forgotten when the electrical means

of producing a dry cold is compared to all old processes which are slowly, but surely, becoming antiquated through their crudeness of design and operation.

Take for instance the week end trip, or if one is called away from home unexpectedly on any occasion. For days at a time, regardless of weather conditions, one can remain away from home with the knowledge that upon his return he will have at his command a refrigerator full of crisp, healthful, appetizing food, which was left or prepared before his leaving.

Also one has on hand an abundant supply of ice cubes to cool refreshing beverages for oneself and guests. In sickness as well as in health cold beverages and an available supply of pure ice are necessary. Such ice is available at any moment of the day or night if one owns such a refrigerating machine.

The risk of impurities which may creep in through unclean ice, in itself justifies a person's consideration of the modern wonder. In addition to this feature there is the opportunity it provides to make frozen delicacies merely by placing liquids in the chamber used to freeze ice cubes from whence they may be used any time without fear of their being too soft for serving.

With the use of electrical refrigeration the marketing problem is reduced to a minimum, for the housewife may purchase perishable foods in quantities, insuring herself of an adequate supply for her own uses or for unexpected guests who might drop in around meal time. In this day, when automobiles are so universally used, the unexpected guest is more likely to drop in than ever before. Yet there is no need for worry or embarrassment nowadays, for the modern housewife may depend implicitly upon the mechanical refrigerator to help her out of the difficulty. When her guests depart they carry with them a remembrance that she more than did justice to the occasion.

After considering these points, in the consideration of convenience, can any electrical equipment be thought of which so satisfactorily eliminates the moment of anxiety or uncertainty, or the labor and drudgery of housekeeping as does the electrical refrigerator?

Pride of Ownership

Next we come to the third valuable feature of electrical refrigeration, that of pride of ownership. Is anyone nowadays satisfied to use the antiquated methods of transportation used by our ancestors? The thirty million automobiles in the United States alone disprove that. Likewise in almost all lines of development the same is true. We all speak more or less of "Ye Good Old Days," but who wants to go back to live them under the same conditions? And so it is the pride of ownership that makes the electrical refrigerator valuable today to its owner.

In our daily life we are bound to admire the latest and most advanced model of any device. Even though one is a car owner, the next succeeding model is the one he wants and being human and an American, he is not satisfied until he is driving it. With clothing it is the same—advanced models are always more in demand. Ask the question, "Why does such a condition exist?" And the answer is that human beings want to be up to date and have the best and most modern devices for their individual use. The desire to be associated with successful people, who readily appreciate a worthy and satisfaction-assuring piece of equipment, is also a common attribute of most civilized people today. Just as our Eastern neighbors are looking forward to the time when they can come to locate on the West coast, or at least visit the Coast, we all look forward to the possession of an electrical refrigerator.

Economy

This leads to the fourth and most vital feature of electrical refrigeration—its economy.

Today a domestic refrigeration machine can be had to suit any individual requirements. As low an initial cost as $250, delivered to any point on the West coast, is available. The installation of such a machine today requires no more labor than that required to put it in place and connect it to an electric service outlet; to turn on the current is to commence the refrigeration process.

The matter of operation costs is also extremely interesting. By referring to Electrical Merchandising for February, 1926, page 6088, one may find that the average cost per refrigerator, per year, for current is $28.08. This is based on a consumption of 864 kw-hr. at .0325c per kw-hr. The average rates on the Pacific Coast, using figures obtained from the Journal of Electricity, are as follows:

Straight lighting schedule	.0525c
Combination schedule	.0325c

If, then, the electric refrigerator is used in conjunction with lighting service, the cost per year closely approximates $45.36 as against $28.08, where it is used in conjunction with an electric range, water heater or air heater. Most of the Pacific Coast territory, however, enjoys a much lower rate, and where an electric refrigerator is used in conjunction with an electric range, water heater or air heater, a rate of 2 cents per kw. is obtainable, making the annual cost for electric energy amount to $17.28 on the average. The figures used throughout this article, however, will be .0325c, which is the average for the Pacific Coast.

Then there comes the question of depreciation. An electrical refrigerator is built for a life of twenty years, or longer. Due to its cleanliness throughout its life, calculations are all based upon that length of life. The ordinary refrigerator, requiring other means of cooling, corrodes and decays due to dampness, and its usual life very rarely extends beyond seven years.

The maintenance cost on an electrical refrigerator is greater than that on an ordinary refrigeration box, but even so the maintenance seldom exceeds $10 per year. This fact was definitely brought out by the Committee on Electrical Refrigeration of the National Electric Light Association, at its 48th convention held in San Francisco in 1925.

Considering all these costs for the electrical refrigeration unit, we have the following figures for the year:

Interest charges of 6% on the investment of $250	$15.00
Electric current costs per annum, 864 kw-hr. at .0325c	28.08
Depreciation—5%—based on 20-year life	12.50
Maintenance per annum	10.00
Total cost per year	$65.58
per month	5.46

Compare those figures, if you will, with the ordinary means of refrigeration, that is, with an ice box costing $75. You will find the figures to be as follows:

Interest at 6% on the investment of $75	$ 4.50
Ice costs—$3 per month for 9 months	27.00
Depreciation (average life of box, 7 years)	10.71
Maintenance at $2 per annum	2.00
Total cost per year	$44.21
per month	3.68

These tables cover all costs involved in owning and operating an electric refrigerator per year, in comparison with the commonly accepted refrigerator box which uses ice as the refrigerant. For the difference between $5.46 and $3.68, which is the actual difference in cost between the two forms of cooling, or $1.78 per month, one gets a service comparable to no other form of cooling process known today. He has, for the small additional sum of $1.78 per month, a health insurance of which the owner himself, his family and guests, are beneficiaries, and he receives the assurance that he is able to maintain clean, wholesome, appetizing food, hygienically preserved. Health insurance, this is, at a cost so low that if his savings from food spoilage and waste were added along with the savings in time, labor and depreciation of other cooling devices, and these in turn were all placed each month in a strong box to be opened at the end of the year, would surprise him to find there an amount of money at the end of that year which would more than offset the entire costs of owning the electrical refrigerating system.

In view of present perfection in electrical refrigeration machines, and their value from the standpoint of health, convenience, the pride of ownership and economy, no home in the United States today can afford to be without some form of refrigeration. Yet an analysis shows that 65 per cent of all homes in the United States are maintained without means of keeping foods cool. Is a person to be satisfied to remain among the 65 per cent? Of course not. He must either invest in a refrigerator box and use ice, or, better still, have a modern electric refrigerator installed in his home.

Electric Heating and Cooking Committee Reports**

Electric Range Sales During 1925 and Range Merchandising Policies*

By E. F. PERKINS

One of the major problems of the electric service company has been that of power plant development, transmission and distribution. The demand for electricity so closely pressed the supply that no great effort could be expended to influence the demand. A new era in the electrical industry is now here with the supply exceeding the demand. This new era gives the industry an opportunity to study the load curves and load factor for each particular system to the end that they can determine exactly what load should be developed in order to improve the load and operating conditions.

A study of the "Progress Report of Electric Range Survey Committee" as issued at the 1925 N.E.L.A. convention has been very enlightening to all who were skeptical regarding domestic cooking load. The completed report will undoubtedly contain further information that will be very valuable to the industry. This report shows that the electric range has a very low demand factor. The domestic electric cooking daily load curve shows three daily peaks, the first occurring between 6:30 a.m. and 8:15 p.m., the second between 11:45 a.m. and 1:00 p.m., the third between 5:00 p.m. and 6:30 p.m. The electric range maximum demand curves show that the range load is decreasing as the lighting load increases to the end that the range load is practically off when the lighting load reaches its peak.

The domestic electric cooking load is therefore a very attractive load, due to its maximum demand occuring when the industrial, commercial and lighting loads are small. The electric range will, therefore, play a very important part in the improvement of load factor.

Electric cookery has proved to the complete satisfaction of all who are using electric ranges that electricity is the ideal fuel for cooking. With the acceptance acknowledged, Table 1 is presented which shows the ranges on the lines of the utilities, who returned our questionnaire, on Jan. 1, 1925, and Jan. 1, 1926. A comparison is also shown between 1924 and 1925 sales. A decided increase in sales is shown by most of the larger companies, some of whom increased their sales force and went out after this business in a very aggressive manner.

The Journal of Electricity has presented us with statistics showing a comparison of wired homes in Arizona, California and Nevada which is shown in Table II.

A study of Table I and Table II shows that 2.3 per cent of the wired homes in these three states are enjoying electric cookery. There was an increase of 64,108 wired homes during the year 1925. It is therefore apparent that the number of wired homes increased during the past year at a rate which is 9 times greater than the number of electric ranges installed.

Table I shows an increase in number of electric ranges in use of 37.4 per cent. A survey of quotas for 1926 indicates that the utilities are anticipating an increase of approximately 35 per cent with only one utility shooting at a quota in excess of this percentage. This utility is one of the largest in the territory and has planned a program which anticipates an increase of 65 per cent in electric range consumers. While there is an increase in general activity, it would appear that only one utility is taking real advantage of the opportunity offered in this field.

The facts should be rather startling to the electrical industry, who, as a whole, have taken little interest in this part of their business. The number of men whose income is from the electrical industry and who have no knowledge regarding the electric range, is also startling. The hardest prospects to sell an electric range are some of our own men. It is needless to say that everyone in the electrical industry is often asked for his opinion regarding electric cookery and it is regrettable that the advice is not based on actual experience. The electric range as we have it today is superior to every other appliance using other fuels for cooking. Is it not important that we again attempt to sell our own industry so that they can be

TABLE II—WIRED HOMES

State	Wired Homes Jan. 1, 1926	Jan. 1, 1925	Increase
Arizona	30,550	29,090	1,460
California	1,154,500	1,091,892	62,608
Nevada	13,630	13,590	40
Total	1,198,680	1,134,572	64,108

** P. P. Pine, San Diego Consolidated Gas & Electric Company, chairman. E. F. Perkins, Pacific Gas and Electric Company, vice-chairman. George Cole, Edison Electric Appliance Company, secretary. Committee personnel as per subcommittee lists with subsequent papers.

* Report of Electric Domestic Cooking subcommittee: M. L. Foster, Coast Counties Gas & Electric Company, chairman; P. H. Booth, Edison Electric Appliance Company; A. E. Carroll, Rutenber Electric Company; Dan Coyle, Pacific Gas and Electric Company; A. M. Frost, San Joaquin Light & Power Corporation; Philip S. George, Coast Valleys Gas & Electric Company; B. Y. Gibson, Walker & Pratt Company; Arthur Kercher; A. W. Krueger, Pacific States Electric Company; H. M. Lippert, A. J. Linderman & Hoverson Company; H. C. Rice, Southern California Edison Company; M. W. Scanlon, Westinghouse Electric & Manufacturing Company; R. A. Sharon, Great Western Power Company; G. D. Smith, Ontario Power Company.

TABLE I—RANGES SERVED BY CENTRAL STATIONS IN CALIFORNIA, ARIZONA AND NEVADA

Central Station	Ranges Installed Jan. 1, 1926	Jan. 1, 1925	Percent Increase 1925	Percent Increase 1924
California Oregon Power Co.	2,289	1,729	33	23
Central Ariz. Lt. & Power Co.	10	6	..	0
Coast Counties Gas & Elec. Co.	195	125	56	67
Coast Valleys Gas & Elec. Co.	658	500	32	54
Desert Power & Water Company	23	15	53	37
Elko-Lamoille Power Company	57	45	27	..
Ely Light & Power Company	2	0	..	..
Flagstaff Elec. Light Co.	20	6	332	33
Great Western Power Company	3,820	2,774	38	32
Los Angeles Gas & Elec. Corp.	215	165	30	25
Nevada-California Power Company	1,255	987	27	0
Pacific Gas and Elec. Co.	8,746	5,715	53	31
San Diego Cons. Gas & Elec. Co.	897	588	52	20
San Joaquin Lt. & Power Corp.	2,469	1,730	43	21
Southern California Edison Co.	5,947	4,947	20	6
Southern Sierras Power Co.	442	321	38	43
Tucson Gas & Elec. Company	0	0	..	0
Vallejo Elec. Lt. & Power Co.	86	80	7	11
Western States Gas & Elec. Co.	350	314	11	52
Totals	27,481	20,047	37.4	24.4

sold on their own appliances? It is needless to say that every electric range sold is a benefit not only to the buyer but to the whole electrical industry.

Consider that the utilities have thousands of miles of distribution lines in residential territory which are only in actual use a few hours in the evening of each day and that the electric range will increase the consumption per residence at least 5 times what it has been. Consider also that the electric range in itself will require practically no additional generation capacity because of its maximum use being during the hours of the day when most other loads are at a minimum. Does this not appear to be the ideal load then to develop?

The problem the industry is now facing is strictly a merchandising one. At the present rate of growth this develops into a major one. At the present time with the many utilities having different sales policies in adjacent territories, there is often confusion in the minds of the general public, especially when the range price differs by 25 per cent or so in nearby cities. This condition can not be termed a healthy one. This report will therefore deal with merchandise policies with an attempt to arrive at the general tendency in the over-all policy.

In analyzing the problems of utility merchandising policies we have several details which go to make up the whole. These details can be classified and will be discussed in the following order:

A. Who should sell electric ranges?
B. What should be the retail price?
C. Should the utilities job electric ranges?
D. Installation.
E. Compensation of salesmen.
F. Special sales activity.
G. Quotas.
H. Advertising.
I. Servicing.

Who Should Sell Electric Ranges?

The more firms and individuals who are pushing electric range sales the more electric ranges will be sold.

The salesmen selling electric ranges are in competition with salesmen selling every other known appliance and device. It is a common statement by prospects, "I certainly would like to own an electric range, BUT we are buying an automobile, or we are going to buy this, that or the other thing." Considering the selling effort being placed behind so many devices it appears that a large and concentrated sales effort must be placed behind the electric range in order to realize on the market that exists. The lead in this movement must be taken by the utility or the prospective consumers will be buying some other merchandise on which there is a more concentrated sales effort.

A statement is often made that the business man of today enjoys every known labor saving device in his business or office. While this statement is perhaps true, we must not lose sight of the fact that the manufacturers or distributors of these appliances have been building up a high class sales organization that has, through efficient sales methods, sold these appliances. This accomplishment was not an easy one and sales effort is responsible for the results.

The problem of an old stove market is of importance inasmuch as everyone has capital invested in a cooking range of some sort. A great many people object to junking this investment until it has actually reached the junk class. It is a general practice among stove dealers to make a trade-in allowance for the old stove. It is then self-evident that unless these stove dealers are promoting the sales of electric ranges that the utilities will have strong competition until they establish an old stove market to meet the problem.

A survey shows that the furniture, hardware and kitchen equipment firms are selling by far the largest majority of cooking appliances. These firms have placed little effort behind the electric range due to the following handicaps:

1. Small demand.
2. Small margin of profit.
3. Inconvenience of installation.

These firms are then the competitors of the electric range. This natural and established outlet for ranges should be recognized and the tendency of existing policies are toward this end.

The general policy in effect today or being considered in the sale of electric ranges is a policy with the utility, contractor-dealer, furniture and hardware stores all merchandising electric ranges. The general attitude is that the utility places itself on the same basis as the other firms and sells directly the prospects which are the result of its own sales effort. The policy will insure the greatest and at the same time most economical concentration of sales effort behind the electric range.

What Should be the Retail Price?

When the electric range was first introduced in this territory the resale price was in most instances established at approximately car-load cost. It was anticipated that this policy would sell a great number of ranges in a short space of time. The fact was overlooked, however, that a demand must be established and a desire to own created before the price is even considered. The sales effort during this period was naturally limited to manufacturers and utilities and had a very high selling cost.

The next period was when the resale price was established at approximately 26 per cent above cost. This policy permitted a little activity by small dealers and permitted a small margin to off-set the selling cost.

We are now passing into the third period when the resale price will be established at list price. This policy will open the field to all dealers and permit legitimate merchandising with advertising and special effort which accompanies such merchandising. Approximately one-half the companies reporting in the recent survey are now selling at list price.

Should the Utilities Job Electric Ranges?

The tendency in this regard with the establishment of list price seems to be away from jobbing. This appears to be a natural move when we consider that manufacturers and jobbers are established in the field to accomplish this function.

Two companies have established special advertising discounts to large dealers who maintain specified displays and who do regular advertising on electric ranges. This discount is better than could be obtained from the regular channels, and is justified by the advertising received.

Installation

At the present time practically all installation work is done by the contractor-dealer. Common practice is to install electric ranges at flat prices. Some utilities limit these flat prices to company direct sales, while others will install ranges for dealers and absorb a loss up to a limited amount. It is quite necessary that means of quoting flat prices be in effect to aid salesmen.

The electrical wiring for residences has passed through two stages and is now entering the third stage, the first stage being the wiring for lights, the second the wiring in of convenience outlets. The third is the wiring specifications as covered by the "Red Seal Plan." This plan should receive the hearty co-operation of the whole industry to the end that this wiring of new homes will be accepted as a matter of fact, just as the hardwood floors and other conveniences are now accepted.

Another aid will be the establishment of a statewide wiring code which will stanrdardize all installations. At the present time nearly every city of any size and a great many counties have local ordinances which cause considerable confusion and at the same time increase costs. This standardization is now being studied.

Compensation of Salesmen

The common practice for compensation of salesmen is on a salary plus a commission basis. This seems to be the most satisfactory method inasmuch as it permits the salesman to control his income.

Special Sales Activity

Special sales are common practice in all merchandising to stimulate buying and move slow moving stock. Utilities should take advantage of this method of merchandising by conducting special sales off and on during the year.

These sales should have an appeal strongly advertised to draw prospects. These sales will in no way interfere with dealer merchandising as they have the same privilege.

Cooking schools followed by special sales result in increased business.

Quota

A quota serves two purposes. It shows the business anticipated during any given period of time. At the same time it shows the salesmen what is expected of them and gives them a standard by which these results are to be measured. The quota should be broken up into districts and finally down to the salesmen's territory. A great deal of enthusiasm can be created by offering quota prizes.

Advertising

Advertising plays a very important part in business of today. This advertising is divided into several classes, such as newspapers, magazine, bill boards, job signs and direct mail. There is a great need for additional advertising. It would probably be a step in the right direction to request the Advertising Committee to study this as a separate problem.

Servicing

It is a common practice for the utilities to maintain an electric service department to service electric ranges, the common practice being to take care of the manufacturer's guarantee during the first year with free labor and after the first year to charge from cost to list for repair parts with free labor. This policy seems to be working very well. In the near future we may hope that the dealer selling the range will be responsible for the service.

The main service problem of today is the matter of range service parts. With the various ranges using different elements and switches it requires a considerable investment in parts. To aid service men and to reduce the repair stock it would seem advisable that the leading manufacturers standardize on elements and switches.

Advantages of Electric Heat as a Part of the Complete Electrical Home*

Three decades ago the man who had electric lights had an electrical home. Ten years later, lamp socket appliances such as the electric iron, vacuum cleaner, and washing machine constituted an electrical home. Then the electric range was added to the necessary equipment. Today the ideal home is the completely electrified one, this modern servant being used for heating and cooking as well as for lighting and domestic appliances.

Equipment sufficient to render these services consists of 110-volt lamps and fixtures, 110-volt appliances such as toasters, waffle irons, and cleaners, range, water heater, large capacity air heaters (1,000 to 6,000 watts), an electric ironer and an electric refrigerator.

The wiring consists of a heavy 3-wire 110-220-volt main service, usually 3 No. 2 wires; 110-volt lighting circuits; 110-volt appliance outlet circuits; 3-wire 110-220-volt range circuit; 220-volt water heater circuit; and a 220-volt circuit for each heater or heating device over 660-watts capacity.

An electric home is made possible by a favorable combination of climatic conditions and of low cost of electric energy. Climatic conditions as found in California have been used in the compilation of the following figures with a combination lighting and heating rate for electricity generally scheduled by the utilities of this state. A typical combination rate applicable to service for an eight-room house follows:

First 30 kw-hr. per month at 7c.
Next 150 kw-hr. per month at 3½c.
All over 180 kw-hr. per month at 2c.

A yearly minimum of approximately 50c per month per kilowatt of connected load, is in effect.

In an average home of eight rooms or less, 30 kw-hr. ordinarily covers the lighting, 150 kw-hr. covers the cooking, and the heating can be considered as carried on a 2c rate.

The important thing about the all electric home is the cost of operation, and it is interesting to know that many homes of from five to eight rooms use from $200 to $300 of electricity per year. This consumption is put on a yearly basis rather than monthly on account of the seasonal heating. The amount is divided about as follows:

Electric lighting and appliances	$ 30 per year
Electric cooking	60 per year
Electric water heating	60 per year
Electric air heating	$50 to 150 per year
Total yearly	$200 to $300

Compare this with the ordinary home, for which purpose the following figures should be adjusted to local rates and prices:

Electric lighting and appliances	$ 30 per year
Gas cooking	25 per year
Gas water-heating	50 per year
Heating (coal and wood)	75 per year
Total yearly	$180

In figuring the cost of operation of a home, most people see only the fuel item, which is only one of several items and sometimes not the most important. Factors contributing to a total cost are:

1. Interest and taxes on first cost of equipment.
2. Maintenance of equipment.
3. Depreciation of equipment.
4. Labor necessary to operate.
5. Fuel or energy.
6. Health and safety.
7. General desirability.

Tangible values can be placed on the first five factors, and the cost for the use of electricity is lower than any other form of service, on all items except fuel. Intangible values in the last two items often prove the deciding feature for electricity. Balancing the low cost of the first four factors against the fuel cost, and accrediting the value of the last two factors, the electrical home is just as economical as any other, and obviously far more desirable.

Arguments for the Electric Home

The all electric home holds an especial appeal for the family in moderate circumstances, which is buying or building its own home, when the wife has a couple of kiddies to look after and is doing her own work. A servant is expensive, but a few extra dollars spent for dependable, economical electrical servants will save many hours and many steps.

Another advantage for the family in moderate circumstances, and who are building, lies in the fact that building costs can be materially reduced. By eliminating a servant's room and bath, a furnace room and flue or two, as much as $1,800 average can be saved.

To some the electrical home represents something "better" and they are willing to pay a little more for comfort, convenience, and added pride in ownership. The first cost of building an all-electric home is usually less and after a year's operation, much to their surprise, they generally find that they have saved money.

Electricity has made of cooking a field of science in which such rapid progress has been made during the last few years that housewives have come to accept electricity for cooking as the modern, best way. It is only a question of time and opportunity until the electric range will take its place in every kitchen. Housewives have come to know that it really

* Report of the Air Heating Sub-committee: C. B. Merrick, Sandoval Sales Company, chairman; G. T. Bigelow, Southern Sierras Power Company; Frank Cronan, Western States Gas & Electric Company; O. R. Doerr, Magnavox Company; Arthur Kempston, Majestic Electric Appliance Company; E. A. Wilcox; J. W. Wrenn, Great Western Power Company.

costs nothing to operate an electric range. The savings in time, labor and food, more than pay the electric bill.

Electric Water Heating

Advantages of electric water heating and air heating are not so familiar to the public. People must be educated concerning the value of this equipment before it will be universally used.

With electricity at 2c per kw-hr., the cost of operation is the dominating factor in electric water heating and practically determines the type of equipment to be used. Intermittent heating is the cheapest method of heating water, as radiation losses are minimized and less hot water is used than where the supply is available at all times.

An external circulation type of heater banks the water at the top of the boiler where it can quickly be drawn off after the heater is started. A 5-kw. heater is the most popular on account of its speed on intermittent heating. All boilers and pipes should be thoroughly lagged, which minimizes radiation losses and tends to keep the tank hot after the heater is turned off.

Heaters should have an automatic thermostatic cut-out as insurance against heater burn-outs and fire hazard. Such a thermostat also permits turning the heater on and automatically maintaining a tank of hot water.

In the ordinary home of from five to eight rooms, it has been found that intermittent water heating takes from 150 to 250 kw-hr. per month, which, at a 2c rate, amounts to $3 to $5. Where the water in a tank is automatically maintained hot and a hot water service is always available, the consumption just about doubles, namely 250 to 500 kw-hr. per month, or $5 to $10. This is due to increase in radiation losses and in use of hot water. Service from this type is most satisfactory but in competition with gas at $1 per thousand cu.ft., it proves more costly.

In order to lower costs, an auxiliary tank has been developed which provides a limited hot water service continuously without heating the main tank. This tank takes care of all ordinary wants, such as cooking and dish washing. When large amounts of water are required, the main tank is heated by opening a valve. This service is quite satisfactory, the consumption varying from 200 to 300 kw-hr. per month, which places it on a cost par with competitive heating.

Water heaters which are well designed and constructed are fairly free from burn-outs and require little service over a long life.

Electric Air Heating

Selling electric air heating in the home at first meets with resistance from consumers on account of their previous experience with lamp socket (660-watt) heaters. They have used these heaters on lighting rates and have failed to get sufficient heat but have received high bills.

The 660-watt radiant heater has a very definite field and when properly sold gives most satisfactory service. It is not intended to heat a room any more than a pocket flashlight is expected to light a room. Both give an intense beam over a limited area only. For spot heating, the radiant heater proves very satisfactory but for raising the temperature of any but the smallest rooms, heaters of two to six thousand watts capacity must be used.

Heat can be classified under two general headings—radiant heat and convection heat. A high temperature mass gives off radiant beams which pass through air without heating it to heat solid objects upon striking them. The rays from the sun are examples of this.

Air passing over or coming in contact with a hot mass at comparatively low temperature absorbs heat and rises and this is known as convection heating.

With radiant heat, the solid objects in the room are at a higher temperature than the air and heat it. With convection heat, the air is at a higher temperature than the solid objects and heats them by contact. It can readily be seen, therefore, that for raising the room temperature, convection heat is more effective than radiant heat.

Electric heaters are built on either of these principles, or a desirable combination of the two. A radiant convection heater dissipating the bulk of its heat by means of convection air currents but giving off a small amount of radiant heat for quick heating and coziness has proved most satisfactory.

Four features are essential in a good electric heater used for room heating in the home. (1) The proportion of radiant heat to convection heat should be properly balanced. (2) It should contain as little mass as possible in accordance with good construction. The greater the mass, the greater the amount of stored heat not immediately available for heating the air. (3) The heater should operate at a temperature sufficiently low that the dust particles in the air will not be scorched and burned, thereby soiling the walls and ceiling. (4) The heater should be so constructed as to require little maintenance and have long life.

It is customary to install a heater in each room large enough to give a comfortable temperature on the coldest winter days. There are few extremely cold days, hence for the average winter day the heater will be larger than necessary.

Heaters are all equipped with three heats so that they can be turned down to meet any condition. The large heater, when turned on full heat for a few minutes in a cold room, will rapidly raise the temperature, after which it can be turned to a lower heat.

With a difference in temperature between the outside and inside of a room, a definite heat transfer takes place from the walls, floor and ceiling, and it is necessary to supply that amount of heat to the room. In the average well constructed house, 1½ to 2 watts per cu.ft. will produce a temperature rise of about 30 deg.

Electric heat is flexible and available in just the quantity desired at all times. One or all the rooms in a house can be heated as required. Automatic heaters will maintain even temperature, doing away with extremes of heat and cold. A hall heater will usually keep the chill off the entire house.

Portable heaters can be moved to suit the housewife's convenience or stationary heaters can be installed in the walls, where they are out of the way and take up no floor space.

One of the big advantages of electric heat is the elimination of flame and combustion with its consequent fire hazard, and the labor and dirt that goes with it. This is of considerable importance in the home with small children, where health and safety are paramount.

Electric heaters are also used with furnace installations for chilly fall and spring days when it is uneconomical and bothersome to start a furnace for just a few minutes, but uncomfortable without some heat.

In comparing electric home heat with artificial gas heat, there is one distinct advantage in the use of electricity—the elimination of sulphur dioxide gas in the air. The ruinous effect of this gas on drapes, furniture and carpets is not generally known. Many of the bleached spots on carpets, drapes and upholstery which are blamed on the sun, and many material failures blamed on poor quality, should be attributed to the action of sulphur dioxide gas.

The public knows the advantages of an all electric home and generally accepts it as better and more desirable than any other, but is dubious as to the operating cost. In this story the endeavor has been made to show that all things considered, the electric home is just as economical as others less desirable. The cost of **kerosene** for lighting is less than the cost of **electricity**, but the almost universal use of electricity for lighting where available would indicate that **electric lighting** is more economical than **kerosene lighting** when fuel, labor, maintenance and fire hazard are taken into consideration.

The public must be educated concerning the costs, other than fuel, which casual thought does not show. Then in sections of the country, where electricity is available, the electric home will predominate.

To summarize, the following question might be asked: "What does the all-electric home mean to industry?" To the contractor it means a wiring job of from $150 to $300, instead of $50 to $75 as at

present; to the dealer it means the sale of $200 to $500 worth of equipment which would otherwise go into other channels; to the electrical jobber and manufacturer it means additional sales of from $200 to $400 per home; to the power company, a revenue of from $200 to $300 per year, instead of $30. Last, but not least, to the consumer it means comfort and convenience at reasonable cost.

The following questions and answers have been prepared to aid the salesman in selling the all electric home to the public.

Questions and Answers

1. Q. Cost of operation?

   A. Considering cost of fuel only as against electricity, first is much less, but considering all actual costs of electric heat against other methods,

   1. Interest and taxes on first cost of equipment
   2. Maintenance of equipment
   3. Depreciation of equipment
   4. Labor necessary to operate
   5. Fuel or energy
   6. Health and safety
   7. General, desirability,

   cost is quite comparable.

2. Q. Cost of Equipment?
   A. For methods of heat which are comparable in performance, cost of equipment is on a parity, and when saving in building cost is considered, due to elimination of flues, furnace room, etc., first cost is in favor of electric heat.

3. Q. Are present installations operating satisfactorily?
   A. Yes; the steady increase in connected load distinctly indicates this fact.

4. Q. Does number of people in room affect capacity required?

   A. Yes; each person is equivalent to 150 watts, and a theatre with 1400 people seated, is equivalent to one with 210 kw. capacity installed.

5. Q. Does humidity affect the temperature at which greatest comfort is secured?

   A. Yes; at 70 deg. greatest comfort is obtained with relative humidity of 36 per cent. If this is increased to 75 per cent, the temperature of greatest comfort is changed to 60 deg.

6. Q. What are the heat losses in the average living room of 12 x 20 x 9 ft. for a 30 deg. rise in temperature?

   A. .24 kw. lost through the floor.
   .72 kw. lost through the ceiling
   1.72 kw. lost through the walls
   .65 kw. lost through the windows
   .35 kw. lost through air change

   3.68 kw.
   .736 kw. (10 per cent lost through windage)
   (10 per cent lost through intermittent ht'g)

   4.416 kw.

7. Q. Interest and Taxes?

   A. These items will probably be less, as they vary in direct proportion to initial cost.

   Q. Maintenance?

   A. Always less on properly constructed and operated equipment.

   Q. Depreciation?

   A. Less, because of longer life.

   Q. Labor?

   A. Decidedly less.

   Q. Fuel?

   A. More.

   Q. Health and safety?

   A. Paramount—as is well illustrated by the fact that the doctors are the easiest to sell on the home electrical.

   Q. General desirability?

   A. Clean, safe, healthful, convenient, labor-saving, instantly available, and odorless.

8. Q. For what consumers, or in what cases would you recommend electric heat?

   A. 1. All electric homes.
   2. Apartments and hotels.
   3. Churches.
   4. Schools.
   5. Theatres.
   6. Offices.
   7. Industrial applications.

9. Q. How much will a fireplace save if used in conjunction with electric heating?

   A. Probably it will cost more than it saves. The draft up the chimney carries the heat with it, and with electric heating, this extra change of air is not needed for ventilation. All flues should be equipped with dampers.

Instructions for the Sale of Heavy Duty Cooking Equipment*

The progress which has been made during the last few years in the preparation of food stuffs and in the art of cooking and baking is very marked; the development has been so thorough that we are now able to procure a majority of foods which have been prepared for the market with the utmost care. Sanitation has so far entered into this work of preparation that we now find most of these articles sealed in air tight containers and packages and in many cases without having been touched by a human hand.

The care used in food preparation should not end with conditioning process and marketing of the raw material, but should continue through the whole cooking and baking system up to the final finish, thereby making it possible to procure a meal in any good restaurant or hotel cooked to your exact liking and order, and served in a dining room properly regulated by mechanical heating or cooling methods to meet extremes of climatic conditions. The dining room should be found scrupulously clean, the walls softly decorated, the light just right, the furniture comfortable, the table linen well laundered, the glassware and china clean and polished, and the service performed by efficient waiters without undue noise or confusion. In fact the whole scheme of things should be so well regulated that the setting is one which is suggestive of ease and comfort, and everything conducive to the enjoyment of a good meal, well prepared and properly served.

As food, no matter how good the quality is, may be spoiled easily by improper cooking or by poor and inefficient kitchen methods, it is evident that the greatest importance must be attached to the idea of better equipped, better lighted, more efficient and more sanitary kitchens and kitchen equipment. The old time kitchen, which for so long had furnished the material for all kinds of stories, has been forced into the discard where it so rightly belongs and in its place is now found the modern kitchen designed by specialized engineers who spare no time or pains to design and arrange kitchens which, besides being efficient and comfortable workshops for the cooks, may also be used to good advantage by the management as a show place for the guests for the purpose of advertising his culinary department.

The evolution of the kitchen to the present point of efficiency has taken about twenty-five years, and as the process of betterment is continuing at even a faster rate, it is reasonable to presume that the future will see even greater changes and improvements. As the old dish washing sink has given way to the modern motor driven dish washing machine, and meats and vegetables are now chopped or ground by power machines, as soups are strained, potatoes mashed and bread and pastry dough mixed by machines electrically operated, so will the main cooking ranges and bake ovens continue to improve in type and fuel used. Considering the great improvements that are being and will be made, it is reasonable to presume that in the not far distant future electric heavy duty cooking equipment will be as much in evidence in kitchens as the electrically operated auxiliary machines are today.

Heavy duty electric cooking in hotels and restaurants is less than ten years old; it is the youngest child of the electric industry but, like an unwelcome child, it has not only been accorded but slight recognition from many sources from which it should reasonably expect substantial support and recommendation, but it has been thrust aside and even scoffed at by the electric industry in general.

The smaller appliances such as domestic electric irons, percolators, toasters and waffle irons, also the electric range, water heater and air heater, and now the electric refrigerator, have been advertised and popularized, and the prospect's initial interest aroused

* Report of the Commercial Cooking subcommittee: W. R. Adams, Pacific Gas and Electric Company, chairman; A. J. Thornley, Southern California Edison Company; R. C. Bragg, Vallejo Electric Light & Power Company; G. W. Cole, Edison Electric Appliance Company; T. A. Reid, Westinghouse Electric & Manufacturing Company; O. F. Anderson, Great Western Power Company.

by well directed, continuous sales campaign work. Salesmen by the thousands have trudged the city streets from door to door, the rural districts have been energetically solicited, millions of dollars have been spent in special advertising, price cuts have been made (sometimes without any regard to the original cost, and the consequent merchandising loss) by the power companies, old appliances have been taken in part payment, long-term payment plans offered, and figuratively speaking "Heaven and Earth" moved in the supreme effort to train the public to do it electrically, with the result that electric labor-saving devices and kitchen ranges are no longer an object of curiosity in the average home, but are universally looked upon as positive necessities.

Unlike the domestic appliances, the heavy duty electric cooking equipment practically has had to stand alone as a rank outsider. It seems strange that this valuable load-building and revenue-making business has been aided by only a few enthusiastic, ambitious and far seeing salesmen, and that like Topsy "has just growed," virtually selling itself by its convenience, efficiency and ruggedness.

Differing from the general opinion of the catering fraternity, electric heavy duty cooking is not a wild dream of the far distant future, believed by many to be conceived by distorted minds and advocated by unbalanced enthusiasts. Heavy duty electric cooking is a realized fact, it is here with us today and, better still, it is here to stay. It is true that its advancement and growth may be seriously retarded by indifference of power companies and dealers to its many advantages and merits, and by lack of attention to its possibilities and opportunities, but the company that is wise, progressive, wide awake and alive to its own interest well can afford to provide adequate facilities for its sale, application and its increasing use in the near future. The 1,000 heavy duty ranges and 4,000 bake ovens installed and in operation in the United States today are the result of a comparatively small amount of pioneering and are the modest beginning of a great industry.

As the object of this article is primarily to stimulate the activities of those engaged in the sale of heavy duty cooking equipment and power by providing some food for thought along sales lines rather than to analyze the various articles of heavy duty electric equipment, from a mechanical standpoint, the following has suggested itself for presentation to those actively engaged in sales work.

Prospects for Heavy Duty Equipment

There are many kinds of places in which electric equipment may be used, ranging from first class to third or fourth class in each particular type. These places include:

Hotels	Industrial Cafeterias
Restaurants	Sanitariums
Cafes	Schools
Cafeterias	Hospitals
Coffee Shops	Churches
Tea Rooms	State Institutions
Sandwich Shops	Government Institutions
Boarding Houses	Private Institutions
Large Private Homes	Recreational Centers
Lodges	Clubs
Bakeries	Camps
Resorts	

The heavy duty cooking equipment which may be used is of such a variety and manufactured in so many sizes in each class, that it is very easy to decide on the article best adapted for the particular place and use, from both a convenience and an economical standpoint. Heavy duty equipment may be divided into two classes, A and B.

Class A includes the heavier and principal articles —ranges, broilers, salamanders and bake ovens. Class B includes the auxiliary articles—waffle bakers, toasters, griddles, hot plates, urn heaters, urns, water heaters, steam table heaters, dish cabinet heaters.

Interviewing a Prospect

When interviewing a prospect who is in the market for kichen equipment for a new hotel or restaurant, or when endeavoring to interest an owner, manager, steward or chef of an existing place in the addition of electrical heavy duty equipment to his present equipment, it will usually be found that he knows nothing at all, or very little about electricity as a fuel or electric cooking in general. He will very likely say that he contemplates using coal or oil and give as a reason for his decision "that he has used the other fuel and is well satisfied with its use," or "that his cook cannot or will not work with electric equipment," or he may state that electricity is too slow for heavy duty cooking or that his fuel bills will be too high. He will perhaps argue that the majority of places similar to his in the neighborhood are using other fuel and that he feels safe in following along the lines laid down by the majority. The excuses and arguments offered by the prospect proves conclusively that he has not been properly informed.

This is the most difficult point of the salesmen's contact with the prospect, and if cleverly and tactfully handled will give him an opportunity for presenting a true and convincing statement of facts, which will be sure to arouse his interest, and pave the way for a future meeting. The salesmen should convince the prospect that it is his intention and the intention of the company which he represents, whether power company or dealer, to help him in every way possible to make his particular place the best in the locality. The salesman should then ascertain the type of place the prospect intends to have, what kind of service he contemplates, the number of people he intends to serve, the number of hours he will run per day, whether the service will be continuous and whether he will use steam for stock kettles and for water heating.

Estimates of Cost

After obtaining this information the salesman should tell the prospect that he will give all the data to his company's engineer for analysis and recommendation, and that after a careful study has been made of the requirements, an estimate of the cost of operation of an electric kitchen as against a kitchen using other fuels will be submitted for comparison.

There are many methods used to make comparative estimates, but perhaps the best method is to make an estimate of the total cost of all the fuel to be used, rather than to make a comparison of operating costs of the main ranges or bake oven only. For instance, if the prospect mentions coal for the ranges, then estimate the amount of coal and the cost per month; also estimate the kw-hr. consumption of all the other (electric) equipment and the cost per month; add the two costs together and the total will be the estimated cost of coal and electricity, then estimate the kw-hr. consumption and cost of a full electric kitchen (range included). The difference between the totals will show the estimated difference between the cost of operation of a full electric kitchen and a combination coal and electric kitchen. This method of estimating will favor a full electric kitchen, particularly where a number of auxiliary articles, such as coffee urn heaters, waffle irons, toasters, hot plates, etc., are used, and where there is a sliding rate, because it will bring all of the cooking into the lower block.

The comparative estimate of costs, whether it favors electricity or the combination of the two fuels should not be given to the prospect immediately. Remember that in any transaction where hard and tedious sales work is necessary price should be the last consideration. Keep in mind the fact that the prospect, in order to insure a paying business for himself, must of necessity keep operating costs down to a minimum. Do not get impatient with him for being skeptical of electric cooking. He is entitled to his views and it is his money that he is to spend.

The salesman's big job is to sell the prospect on electric cooking. The delay gained by withholding the estimate will give the salesman the opportunity to elaborate on the advantages of electric cooking and electric cooking equipment. To successfully do this and to properly handle the deal to a satisfactory conclusion, it is absolutely essential to be able to determine the proper equipment necessary for the particudar place. It is also necessary to know the equipment proposed, know it from every angle, its

construction, the material used in its manufacture, why it is constructed as it is, know how it will perform and be able to demonstrate the operation, know what results it will accomplish, the amount of work it will turn out in a given time and at what cost and how to conserve electricity and kitchen labor. It is equally important that the salesman be familiar with the equipment and operation of the equipment suggested by the prospect for other fuel, otherwise it will be impossible to correct false impressions which may be created in the mind of the prospect by other interests. It is further important that a study be made of kitchens and the various articles of kitchen equipment and their relations one to the other and the whole arrangement to the dining room.

A kitchen bears practically the same relation to the dining room that a factory bears to the sales room, each depends on the other. The requirements of the sales room to a very great measure determine the quality of the product which must be produced by the factory for sale. If the factory is inadequate by reason of poor methods, machines, or equipment the sales are bound to suffer because the required quality of the finished article cannot be offered to the buying public. So it is with the restaurant or hotel. The food must be of the best to meet the particular service and must be properly turned out of the kitchen, otherwise the dining room, no matter how well appointed or managed is bound to suffer. Therefore, the help which a power or electric salesman may be to the prospect cannot be too strongly emphasized. Enthusiasm will go a long way toward convincing the prospect, but knowledge will in all probability put over the job if strengthened with patience, sincerity, tact and honesty, for these characteristics will inspire confidence of others in himself.

Where it is found that a decided prejudice exists against electric cooking and it is apparent that the major articles of equipment cannot be installed, the salesman should endeavor to sell the idea of smaller auxiliary equipment such as waffle irons, coffee urn heaters, etc. Waffle irons perhaps offer the best means of getting an electric toe-hold in the places, as they should be easy to sell, for what is more repulsive than to see in a restaurant window a black, greasy waffle iron and what is more appetizing than to see a clean, bright, heavy duty waffle iron, operated by a neatly dressed girl. The waffles are made as easily as bread is cut for a sandwich and without the grease or smoke so much in evidence when using the older methods.

The electric bake oven is another article that has proved to be a big success and is one that has the endorsement of many of the leading bakeries and hotels through the country. It, like many of the smaller articles, has sold itself to the baker and chef by its efficiency, convenience and economical operating cost. Uniformity of baking, elimination of excessive loss due to shrinkage, ease of control, wide range of temperature between the decks of a multiple deck oven due to complete insulation are its chief recommendations.

Testimonial Letters Helpful

Testimonial letters from satisfied users of heavy duty equipment will be a big help in making sales, particularly if they refer to some place in the vicinity, as the prospect will be able to get first hand information regarding the efficiency, cleanliness, etc., of electric fuel. Photographs of the building in which the equipment is being used are also of assistance, much more so than pictures of the installation, as they give a better impression of what can be done because the prospect, when looking at a picture of a large hotel, will have to admit to himself that there must be some merit in electric equipment and electricity as a fuel if a building of the size shown in the picture can use it. The salesman should endeavor to obtain as many testimonial letters and photographs as possible and he should always have them with him when interviewing a prospect. A full list of equipment used in the place, together with a statement of kw-hr. used and electric bills covering a period of a number of months will, if tactfully handled, go a long way toward answering the arguments and objections offered by the prospect.

Special articles in trade papers and magazines devoted to hotels, restaurants, bakeries, hospitals, etc., are good mediums of sales advertising, particularly if the articles are written about some hotel in the vicinity and the story is woven around the electric kitchen or bakery. The salesman should make it his business to see that these articles get into the hands of prospect, if possible before he calls on him, as he will then be in a receptive mood and it will be much easier to hold his attention.

Prospect Lists

A sufficient number of prospects must be on hand at all times. A card should be made for every prospect developed, whether it is for new work, replacement or additional equipment. All information obtained from every source such as trade papers, newspaper items, building reports and from contact with allied trades, supply houses furnishing provisions, should be recorded on the card, together with the date it was received. The result of each contact with the prospect should also be carefully recorded, also the date of the interview. These cards should be kept in a properly indexed cabinet so that they will always be automatically brought to the salesman's notice. This will make it possible for him to concentrate on the prospects which need immediate attention.

Electric cooking will sell itself to the general public if properly advertised and there is no better way to advertise electric cooking generally than to sell the idea to the prospect of the many advantages of front end (window) cooking, flatter him if necessary by complimenting him on his foods, and give him the idea that more people would appreciate his good cooking if they could see it cooked. Sell him the idea of electric cooking by picturing the beauty, advertising value, efficiency and cleanliness of electric heavy duty equipment. Show him how his window or back counter may be converted into an art shop by a few changes, where people will have an appetite created and really forced upon them by actually seeing delicious waffles baked and the prospect will usually place the order with very little further sales effort. An attractive electric broiler or rotisserie are also articles of equipment which, if properly installed, will tend to create a desire on the patron's part and help to advertise the restaurant.

Satisfied customers are the best supporters that a salesman can have. Therefore, in order to surround himself with a number of boosters to whom he may refer prospects, he should, after an installation has been made, make occasional calls at the kitchen, get acquainted with the kitchen help and in every way possible offer helpful suggestions relative to the operation and care of the electric equipment for it is likely that the cooks have been accustomed to working on other ranges and it will require some time for them to get accustomed to the new equipment.

The range pots and pans should be inspected to make sure that they are of the proper size to fit the range top and oven, also that the bakers pans and sheets properly fit into the oven without loss of space in order that the maximum efficiency may be obtained.

Sales Arguments

The following are a few of the statements and arguments usually presented by a prospect and also some of the questions asked and the arguments and answers which a salesman may use to good advantage;

Q. How much will it cost to install an electric kitchen?

A. Tell him that you will have a specification of the equipment and the cost of the equipment ready for him in a few days.

Q. How much will it cost to operate an electric kitchen?

A. Tell him that you will go into all the particulars and will submit an approximate estimate of the cost of operation along with the specifications and equipment cost.

Q. Electricity is too slow.

A. Call his attention to the speed and efficiency of the waffle iron, cake griddle, broiler and bake oven as compared with other fuel on the same articles.

Show him how he can get a maximum efficiency from his range top by using the proper sized pots and pans.

Q. Electricity is too expensive.

A. Show him a list of equipment, number of meals served and cost of operation in some place similar to his. Show him the schedule used and work out a comparison with the local schedule in effect. Show him how he can effect a saving on foods due to the lack of shrinkage of roast meats, etc. Show him the way to conserve fuel by properly operating the switches and reducing heat in parts not in actual use.

Q. Electric equipment is too hard to operate.

A. Show him that it is just as easy to turn the switches on an electric range as it is to shovel coal into a firebox or to operate valves on an oil burner. Call his attention to the wide and positive range of temperature due to the various heat controls and the manner in which they are marked on the switches. Appeal to his intelligence by mentioning the fact that if cooks in other places can operate electric equipment successfully that a man like him would have no trouble at all.

The following are a few things that a salesman should remember when interviewing a prospect:

The prospect is being solicited to spend his money for equipment that he knows very little about. Therefore, he will have to be shown that he will be able to make a success of his business.

Remember that he has been used to seeing a fire in other equipment and is used to regulating his cooking by the size of the flame. Do not forget to sell him on electric cooking before talking price of equipment or operating costs.

Electric Water Heating*

Hot water for household use has gradually passed through various stages, from that of a luxury, to one of absolute necessity. Nothing is more essential to healthful conditions. Once continuous hot water service at reasonable cost has been enjoyed, it becomes one of the most indispensable conveniences of the modern home.

It is a well established fact that an automatic electric water heater of relatively small kilowatt capacity, connected to a well insulated boiler, will supply perfect continuous hot water service, and show better load characteristics than any other class of domestic load. In fact it seldom necessitates increasing the transformer capacity where an electric range is installed, whereas it increases the revenue from 100 to 200 per cent.

An electric water heater serves to keep the electric range sold, and to increase the revenue to the power company from it by keeping fuel-consuming devices, which otherwise might be used for part of the cooking, out of the kitchen.

Electric water heaters should be provided with thermostats in every case. If continuous automatic hot water service is not desired, then the thermostat cuts off the current in case the user neglects to turn it off. Where continuous hot water service is maintained, the thermostat cuts off the current at the proper time, thus economizing in the use of power.

No apparatus used in the home operates with less attention than the electric water heater. Fuel systems function efficiently only when regularly serviced by cleaning burners, heat absorbing surfaces, vents and flues. Methods which eliminate this expensive servicing are most desirable.

Electrically heated water systems require no burners or flues, operate over long periods of time without attention, and give off no products of combustion. No heat is lost through flues, poor combustion or inefficient heat absorption.

It is important that the system should include effective insulation against heat losses through radiation, proper storage, adequate heating capacity, and automatic temperature control.

* **P. P. Pine,** San Diego Consolidated Gas & Electric Company, chairman. **Ontario Power Company:** F. L. Allen. **Truckee River Power Company:** O. S. Clifford. **San Diego Consolidated Gas & Electric Company:** Alfred May. **Sandoval Sales Company:** H. E. Sandoval.

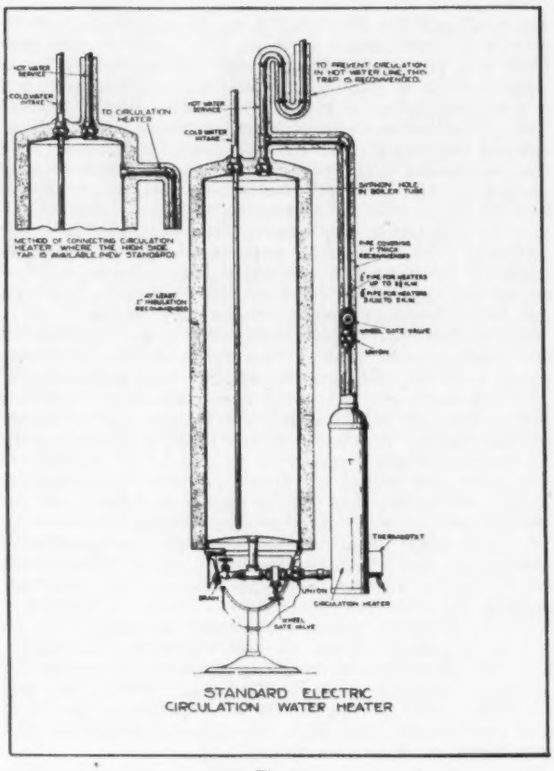


Fig. 1

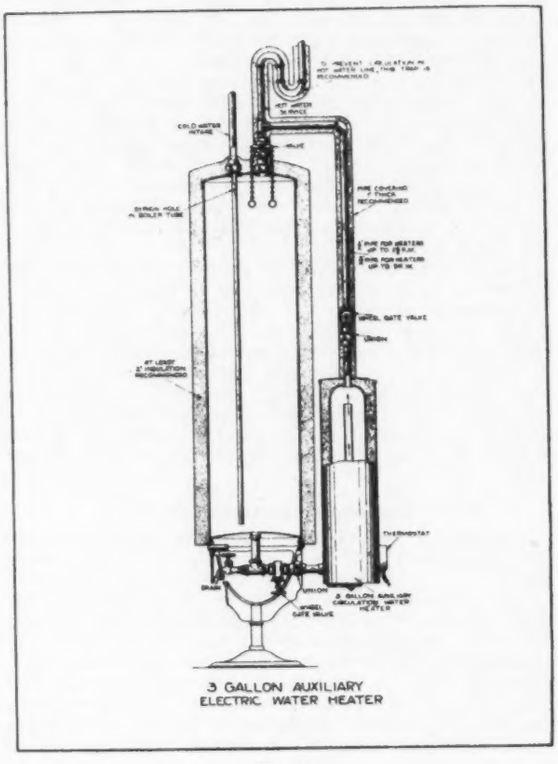


Fig. 2

Installation

The importance of proper installation of electric water heaters cannot be overemphasized. Several diagrams showing correct methods of connecting water heaters, are shown in Figs. 1, 2, 3 and 4. Many troubles will be avoided if installations are made exactly as shown. It is especially important that the pipe tee at the top of the boiler shown in Fig. 1 be

set vertically as shown, and that the bottom of the heater be mounted as low or slightly lower than the bottom of the boiler. A good rule is to connect the heater to the boiler with as few fittings as possible, using not more than two elbows, two tees, two unions, and two wheel gate valves.

The boiler should be located as near the center of the hot water distribution system as possible. The connections between the boiler and the faucets should be made by the shortest routes, likewise the connections between heater and boiler. Hot water is required at the kitchen faucet most frequently and it is desirable to have the boiler as close to it as possible.

Insulation

The present standard recommendation for boiler covering is 2-in. or more of hair felt, rock wool, magnesia or other equally efficient insulation. The pipe from the heater to the boiler should be insulated equally

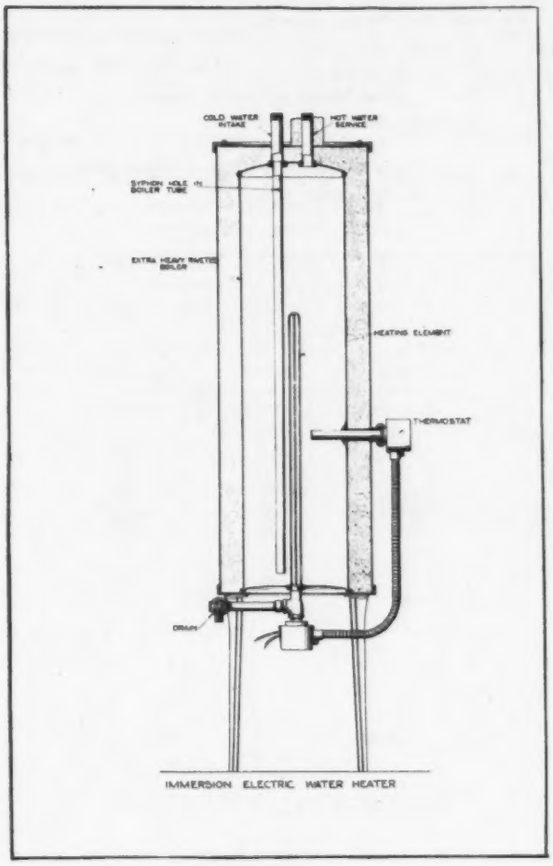


Fig. 3

as well, because bare pipe losses average from 30 to 60 kw-hr. per month, depending upon pipe sizes and temperature differences. A bare 30-gal. boiler kept hot constantly will radiate away 400 to 600 kw-hr. per month. If, however, the boiler is well insulated, the pipes between the heater and the boiler properly covered, and the heater itself well insulated, this loss usually will not amount to over 60 to 90 kw-hr. per month.

Where the hot water pipe rises vertically from the boiler, and particularly where it runs to the second floor, considerable heat loss can be avoided by inserting a "U" trap in the hot water line where it leaves the tank. (Fig. 1.) This is an inexpensive fitting, resembling the letter U, and costs no more than an ordinary pipe union.

Substantial savings can be effected by covering all the hot water pipes throughout the building. The cost is usually quite small in buildings under construction. In many completed houses the pipe to the kitchen at least can be covered without great expense.

This same care should be taken to insulate the boiler and all the hot water pipes, regardless of the type of heater, and regardless of whether or not water is to be kept constantly hot.

Thorough insulation is desirable because very often the heater is used eventually to supply continuous hot water service. If the cost is reasonable, the improved service will be appreciated so much that the user cannot do without it.

TABLE I.—Galvanized cylindrical storage tanks

Approximate Capacity Gal.	Diam. In.	Length ft.	Area Sq. Ft.	Watt Loss per deg. F. temp. diff. per hr. (Bare Surface)	Watt Loss per deg. F. temp. diff. per hr. (85% Eff. Insulation)
12	10	3	8.945	5.367	.805
18	12	3	10.995	6.597	.989
21	12	3½	12.566	7.540	1.31
24	12	4	14.137	8.482	1.272
24	14	3	13.133	7.88	1.182
27	12	4½	15.707	9.424	1.414
28	14	3½	14.966	8.98	1.347
30	12	5	17.278	10.367	1.555
32	14	4	16.798	10.078	1.512
35	13	5	18.860	11.316	1.697
36	12	6	20.420	12.252	1.838
36	14	4½	18.631	11.179	1.677
40	14	5	20.464	12.278	1.842
42	16	4	19.547	11.728	1.759
27	16	4½	21.641	12.985	1.948
48	14	6	24.477	14.477	2.172
52	16	5	23.730	14.238	2.136
53	18	4	22.384	13.430	2.015
63	16	6	27.925	16.755	2.513
66	18	5	27.096	16.258	2.439
79	18	6	31.809	19.085	2.863
82	20	5	30.543	18.326	2.749
98	20	6	35.779	21.467	3.22
100	22	5	34.079	20.447	3.067
120	22	6	39.837	23.902	3.585
120	24	5	37.699	22.619	3.393
144	24	6	43.982	26.389	3.958
168	24	7	50.265	30.159	4.524
192	24	8	56.5549	33.929	5.089

Water Heater Capacity

Most of the power companies encouraging the use of electric water heaters have established standard recommendations as to water heater capacities. These recommendations are generally based on local experience, and water heaters suitable to meet most of the consumers' requirements are available.

Tables II, III and IV, which are taken from advance copy of "Electric Heating" by E. A. Wilcox, will suggest proper heater capacities, and Table V shows the boiler capacity most often required.

Although a salesman is wholly justified in feeling that he is rendering the consumer a service by selling him an electric water heater, he should keep in mind that it is a difficult and needless task to attempt to revolutionize the consumer's habits of living against his will, particularly those of bathing.

An automatic heater that will supply intermittent hot water service will supply continuous hot water service equally as well at the consumer's will. It is often better to encourage the use of the water heater intermittently at first in order to render a service approximately the same as the consumer has been used to, until the convenience of continuous hot water and the possible economies become apparent.

Study of Table IV will serve to show why instantaneous electric water heating is usually impractical, particularly on account of load characteristics, such as demand and revenue per kilowatt of connected load.

"Most electric water heaters have their heating element completely immersed in the liquid itself, and practically all the heat generated is imparted directly to the water. Water is heated by convection currents set up within the substance itself. These convection currents are created by the difference in weight of hot and cold water. Whereas at 32 deg. F. water weighs 62.42 lb. per cu.ft. it weighs only 59.76 lb. at 212 deg. F. It is the difference in weight that causes the top of a storage tank to become hot before the bottom, and which creates the circulation in the ordinary hot water heating service."*

Cost of Heating Water

Water has the highest specific heat of any known liquid or solid, or in other words requires more heat

(*From advance copy of "Electric Heating" by E. A. Wilcox.)

per unit of weight to raise its temperature than any other liquid or solid. This is, of course, true regardless of the kind of fuel used.

TABLE II.—Kilowatt capacity to heat water at 100 percent efficiency.

Quantity of Water in Gal. per hr.	Temp. Rise Deg. F	Kilowatt Capacity Required
1	50	.122
	100	.244
5	50	.611
	100	1.222
10	50	1.222
	100	2.444
15	50	1.832
	100	3.664
25	50	3.054
	100	6.108
50	50	6.108
	100	12.215
75	50	9.161
	100	18.323
100	50	12.215
	100	24.430

TABLE III.—Water heater performance at 100 percent efficiency

Kilowatt Heater Capacity	Temp. Rise Deg. F.	Gal. per.hr.
1	50	8.187
	100	4.093
2	50	16.373
	100	8.187
3	50	24.560
	100	12.280
4	50	32.746
	100	16.373
5	50	40.933
	100	20.467
10	50	81.866
	100	40.933
25	50	204.665
	100	102.333
50	50	409.330
	100	204.665
100	50	818.660
	100	409.330

TABLE IV.—Instantaneous water heater performance at 100 percent efficiency

Heater Capacity	Gallons of water heated 100 deg. F.				
Kilowatts	1 min.	5 min.	15 min.	30 min.	1 hr.
1	.068	.341	1.023	2.047	4.093
2	.136	.682	2.047	4.093	8.187
3	.205	1.023	3.070	6.140	12.280
4	.273	1.364	4.093	8.187	16.373
5	.341	1.706	5.117	10.233	20.467
10	.682	3.411	10.233	20.467	40.933
25	1.706	8.527	25.583	51.166	102.333
50	3.411	17.055	51.165	102.333	204.665
100	6.822	34.111	102.333	204.665	409.330

TABLE V—Sizes of boilers

Small homes	30 gal.
Medium sized homes, 8 rooms with 2 baths	40 gal.
Large homes, 10 to 12 rooms with 3 baths	50 gal.
Very large homes	60 to 100 gal.

The following tables show the specific heat of liquids and solids:

Specific Heats of Various Substances (Kent)

Liquids

Water	1.0000	Mercury	0.333
Lead (melted)	0.0402	Alcohol (absolute)	0.7000
Sulphur (melted)	0.2340	Fused oil	0.5640
Bismuth (melted)	0.0308	Benzine	0.4500
Tin (melted)	0.0637	Ether	0.5034
Sulphuric acid	0.3350		

Solids

Antimony	0.0508	Tin	0.0562
Copper	0.0951	Steel (soft)	0.1165
Gold	0.0324	Steel (hard)	0.1175
Wrought iron	0.1138	Zinc	0.0956
Glass	0.1937	Brass	0.0939
Cast iron	0.1298	Ice	0.5040
Lead	0.0314	Sulphur	0.2026
Platinum	0.0324	Charcoal	0.2410
Silver	0.0570	Alumina	0.1970
		Phosphorus	0.1887

During the war the United States Government Fuel Administration pointed out that 66 per cent of all the heat used in homes in the United States was for domestic water heating. This emphasizes the fact that even fuel methods of heating water are expensive.

Where coal ranges are used with a water back to heat the boiler, they would be used only a few hours a day, if it were not for the hot water requirements. When hot water is required the ranges are kept going all day and often until 8 or 9 o'clock at night. This is a most inefficient way to heat water, although the user often thinks he is getting hot water service without additional cost.

The following tables are averages taken from the records of two of the largest power companies in California:

Small Homes

Water heated intermittently	125	to 200	kw-hr. per month
Three gallons kept hot constantly and main tank heated intermittently	175	to 300	kw-hr. per month
Hot water service maintained automatically	250	to 500	kw-hr. per month

Medium Sized Homes (8 rooms)

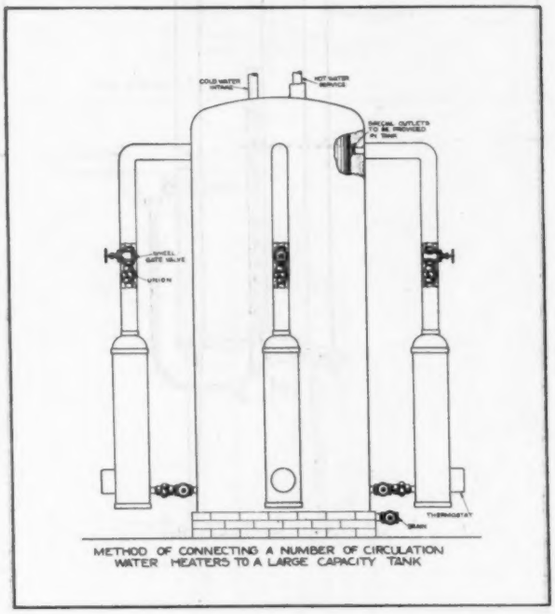
Three gallons kept hot constantly and main tank heated intermittently	200	to 350	kw-hr. per month
Hot water service maintained automatically	500	to 750	kw-hr. per month

Large Homes (10 to 12 rooms)

Hot water service maintained automatically	600	to 1,250	kw-hr. per month

Very Large Homes with Three or More Baths

Hot water service maintained automatically	1,000	to 2,000	kw-hr. per month



METHOD OF CONNECTING A NUMBER OF CIRCULATION WATER HEATERS TO A LARGE CAPACITY TANK

Fig. 4

Servicing Water Heaters

All standard makes of electric water heaters are guaranteed by the manufacturer for one year, when used on normal voltage, and connected properly.

Most electric heaters are built so that the heating unit can be easily removed for inspection, repair or replacement on the job and the service man usually needs to have in the worst case of trouble, only an extra heating unit or part.

In case of leaks in the shell of the water heaters or other trouble which the repair man cannot readily correct on the job, it is usually best to return the heater to the factory or service station for repairs, but this should seldom be necessary unless there is excessive pressure or the heaters are otherwise abused.

The guarantee usually provides that the manufacturer will be responsible only for repairs made in the factory, other than to supply replacement parts.

All service men should be equipped with a voltmeter and an ammeter, so that he will be able to check the voltage and the current wherever he is called on for service.

Without these instruments, it is difficult for a service man to ascertain whether or not the heater is pulling full load.

Question and Answers for Electric Water Heating Manual

1. Q. What advantages have electric water heaters over the usual fuel heaters?
   A. Electric water heaters operate silently, maintain a uniform temperature, are approved by the Underwriters' Laboratories of the National Board of Fire Underwriters, and create no fire or casualty hazards. They operate over long periods of time without attention, and are inexpensive to service or repair.
2. Q. Is a thermostat a necessary part of the water heater?
   A. The heating and cooking committees of the Pacific Coast Electrical Association have recommended thermostats in all their reports for the last four or five years. If continuous hot water service is to be maintained, the thermostat is absolutely necessary for safety and economy. If the water is to be heated intermittently, the thermostat serves to turn the heater off in case the user neglects to do so.
3. Q. Should an electric water heater be sold with each electric range?
   A. Yes, because it helps to keep the range sold, and to keep fuel consuming devices, which might otherwsie be used for part of the cooking, out of the kitchen.
4. Q. Is it important to install the heaters as recommended by the manufacturer?
   A. It is extremely important in order that the heater may produce the best results.
5. Q. Should the heater and the pipes from the heater to the boiler be insulated against thermal losses?
   A. Yes. (See Insulation, page —.)
6. Q. How can I determine the amount of water that a given size unit will heat?
   A. See Table III, page —.
7. Q. What size storage tank should be used?
   A. See Table V, page —.
8. Q. What is the usual consumption in kilowatt-hour in small homes using electric water heaters?
   A. Small homes, see page —.
   Medium size homes, see page—.
   Large homes, see page —.

Lighting Committee Reports*

Lighting Bureau Talk Heard by Business Men in Seventeen Cities

By CLARK BAKER, SR.

The lighting bureau designed a thirty-minute talk with lighting demonstrations, which was given to 35 clubs in 17 cities, comprising the largest towns in the state of California. This talk was published in the Journal of Electricity, Feb. 15, 1926, p. 127.

In these 35 clubs a total of 3,086 people were addressed. The list of clubs represents such progressive groups as Rotary, Kiwanis, Electrical, Advertising, etc. Following is a list of towns, clubs and attendance, in tabulated form:

TABLE I.—Civic clubs addressed by Lighting Bureau

	Town	Elec.	Rotary	Kiwanis	Lion	Ad.	Exchange			Total	Total Atten.
1	San Francisco	1	..	1	..	..	..	1	1	4	466
2	Los Angeles	1	..	..	..	1	..	..	..	2	240
3	Oakland	1	..	1	..	1	1	1	4	9	608
4	San Diego	1	1	1	..	..	1	..	1	5	699
5	San Jose	..	..	1	..	..	..	..	1	2	147
6	Glendale	..	1	..	..	..	..	..	..	1	65
7	Berkeley	..	1	..	..	..	..	..	..	1	158
8	San Bernardino	..	1	..	..	..	..	..	..	1	120
9	Fresno	..	..	1	1	..	..	..	..	2	150
10	El Centro	..	..	..	..	..	..	..	1	1	33
11	Sacramento	..	..	..	..	1	..	..	..	1	24
12	Huntington Park	..	1	..	..	..	..	..	..	1	64
13	Gilroy	..	1	..	..	..	..	..	..	1	35
14	Chico	..	1	..	..	..	..	..	..	1	90
15	Bakersfield	..	1	..	..	..	..	..	..	1	80
16	Santa Rosa	..	..	1	..	..	..	..	..	1	40
17	Richmond	..	1	..	..	..	..	..	..	1	67
	Total	4	9	6	1	3	2	2	8	35	3086

In addition, the talk was re-written for radio and was broadcast in three "doses" over KGO, Oakland, Calif.

The committee feels the results were two-fold, commercial and good-will. Realization of the commercial value was the response of the groups approached. Many, many inquiries came to various branches of the industry for information and data directly as a result.

Further value was evidenced by the thoughtful and intelligent questions asked at the conclusion of each meeting.

The committee does not hesitate in saying over three thousand people were started along the road of thinking better lighting.

Good-will was evidenced in the committee's opinion by editorials, among which the following appear:

"Miniature shop windows, store rooms and living rooms were shown under varying light intensities and colors illustrating graphically the need for proper knowledge and care in the design of artificial lighting for all purposes.

"This and similar talks are being given to electrical men throughout the state." * * *

"What the makers of artificial light have done with their medium is summed up in this comprehensive and yet simply stated lecture. It presents a record of achievement in illumination, and yet points to possibilities for future and more thorough application of artificial light to the various phases of human activity." * * *

Light Without Glare

"The trouble with the address last Wednesday was that the speaker hit only the high spots, gave us little glimpses of fields too much unknown, left us wanting more. Sometimes we get a grain of wheat in a bushel of chaff, a mite of result after a mountain of effort, messes of words. Here we had fullness of knowledge and ability to impart it, aptness of illustration without excess, movement systematically forward, proof through demonstration."

The committee would like to advance its belief that there was a substantial element of public relations involved in this program, meaning the talk had no direct sales purpose. Rather, it represented a service rendered by the electrical industry through the agency of the Pacific Coast Electrical Association.

We did not say—"What you need is more light;" what we did say was—"Inasmuch as you are using light, why not learn more of its fundamentals and principles, thereby securing for yourselves a maximum of service and satisfaction. Let the electrical industry assist you in this."

Recommendation

With the average lighting intensity much below standard of illumination, together with the average store needing from 40-50 per cent more illumination, it seems if even a small percentage of the three thousand business men addressed were awakened to new things, a vast field of business would be opened to the industry.

In consequence, the retiring chairman recommends for future activities serious consideration be given work similar in nature by the association.

*Clark Baker, Sr., National Lamp Works, chairman, Southern Committee. L. A. Hobbs, Edwin F. Guth Company, vice-chairman; Dr. Arthur E. Hoare, Los Angeles School of Optometry; G. G. Hitchcock, Pomona College; D. C. Pence, Illinois Electric Company; G. H. P. Dellman, San Diego Consolidated Gas & Electric Company; Frank von Gilluwe, C. W. Cole & Company; T. L. Nudd; W. R. Chawner, Southern Sierras Power Company. Central Committee: C. D. Monteith, Pacific Gas and Electric Company, vice-chairman; R. S. Prussia, Westinghouse Lamp Company; George Rucker, Holophane Company; M. C. Hixson, Edison Lamp Works; Louis F. Leurey; J. R. Cravath; Romaine Myers; Leo G. Gianini, Edison Lamp Works; H. H. Courtright, Valley Electrical Supply Company; C. O. Martin, Benjamin Electric Company; Victor W. Hartley, California Electrical Bureau; L. H. Townsend, Pacific States Electric Company.

Recent Developments in Street and Highway Lighting*

Everyone recognizes the importance of highways in the great development of the Pacific Coast. Consider what a loss it would be if the usefulness of a large percentage of highways were destroyed. Such a loss would amount to a great calamity and would check the growth and prosperity of the entire community.

On the other hand if the usefulness of these highways is materially increased we are bound to have a corresponding increase in development and pros-

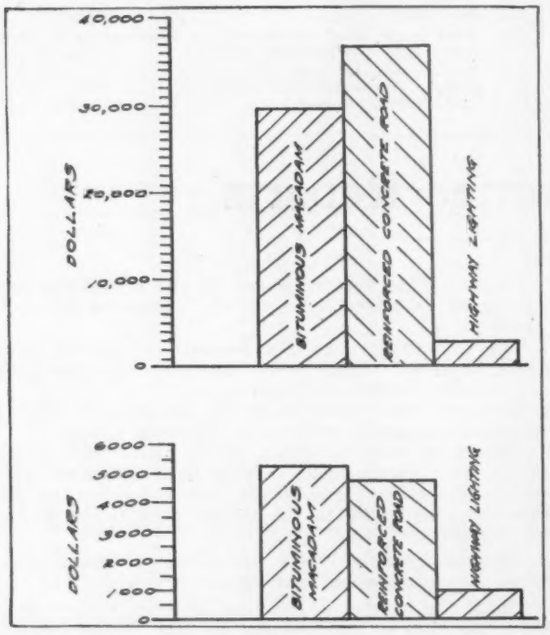


Fig. 1. Relative investment and maintenance cost per mile of highways and lighting.

perity. Today adequate highway lighting is recognized as the solution to the problem of increasing the capacity of existing highways to accommodate the tremendous increase in motor car traffic.

The problem of adequately lighting a highway at reasonable cost was solved by the development of units especially designed to meet the requirements. Such units consist of reflectors or refractors which direct all of the available light of a small lamp in two beams along the road surface. By this concentration of light along the road there is no light wasted upward or outside the highway.

Lamp Size and Spacing

With 2,500-lumen lamps spaced 300 ft. on one side only, the highway becomes a ribbon of light and driving with dimmed and even without headlights is safe. The 300-ft. spacing is preferable, but good results are possible within a range of from 250 to 400 ft. Spacing must vary, of course, to conform to existing pole spacings in many cases.

Mounting Height

Because of the concentration of light and wide spacings highway units should be mounted 30 to 35 ft. to light center. This removes any glare from concentrated light by placing it above the line of vision and permits the necessary spread for an even distribution.

Cost

The relatively small cost of lighting compared with the cost of highway construction and maintenance is shown in Fig. 1. The maintenance includes interest at 6 per cent and depreciation on the investment amounting to 10 per cent for macadam, 5 per cent for reinforced concrete and 20 per cent for lighting equipment (highway 16 ft. wide). The investment cost of lighting equipment is based on 300-ft. spacing, with 250-cp. "Mazda C" series lamp 30 ft. above roadway.

The investment shown above for highway lighting includes new pole line installed for the lighting units. This investment will be materially decreased where existing pole lines are used. It is estimated that such installations will cost installed about $1,700 per mile.

General

Perhaps the most interesting test of modern highway lighting has been the lighting of the ideal section of the Lincoln Highway in Indiana. (See photograph of this lighting Fig. 2.) Here the results were very carefully noted as this was a model highway. Therefore it should be of interest to know that officials of the Lincoln Highway Association predict that within the next decade the entire 960 miles of highway between New York and Chicago will be illuminated. They believe that the increase in traffic and particularly the development of freight transport by fleets of trucks operating at night when passenger traffic is at a minimum, will make lighting absolutely necessary.

It is significant that these authorities are beginning to refer to highway lighting as an absolute necessity. And it is a necessity, just the same as anything else on which depends an important part of our modern transportation system. Not only is it necessary to facilitate night trucking, but it is a vital necessity from the standpoint of public safety.

The annual loss of life and serious injury due to automobile accidents is appalling and is receiving widespread attention. A large percentage of these accidents occur at night due to inadequate or improper lighting. Headlight glare causes many accidents and this menace does not exist on a properly lighted highway. Modern highway lighting eliminates headlight glare because it removes the cause, which is contrast between the brilliant headlight and a dark background.

Fig. 2. Modern highway lighting on ideal section of the Lincoln Highway.

Summary of Advantages

There are other advantages of vital importance to the central station and to the community. Briefly some of the advantages worth serious consideration are as follows:

1. Public safety insurance. Prevention of accidents alone will save property worth more than cost of lighting, not to mention the more important saving of life and limb.
2. Increases trucking and other night traffic relieving day congestion. Also decreases running time.
3. Strong factor in farm electrification. Provides pole line carrying service to isolated districts.
4. Increases property values by promoting development along highways and by bringing electrical service with its conveniences to districts where the in-

* Report of subcommittee on Street and Highway Lighting; E. M. Koch, General Electric Company, chairman; R. E. Conlisk, Westinghouse Electric & Manufacturing Company.

vestment in transmission line would not be possible without the highway lighting as a foundation.

Already practically every state in the Union has installations of modern highway lighting. In several Eastern states many of the important highways have been illuminated and have attracted such favorable attention that plans are being made to light all highways.

The consensus of opinion seems to be that the cost of the lighting installations should be included in the cost of the highway. In several states laws have been passed enabling county supervisors to appropriate county funds for lighting highways. It is

Fig. 3. Highway lighting installation at San Rafael, Calif.

recommended that careful study be made to determine whether or not new laws are needed in California, in order to properly finance highway lighting on a statewide basis.

Because of its wonderful power development the Pacific Coast leads the world in the use of electrical conveniences. We are behind many eastern states, however, in the important matter of highway lighting. As soon as this condition is fully recognized the Pacific Coast will not be long in gaining the leadership in the use of electricity for highway lighting. Leadership in the East today is due to the fact that the advantages of highway lighting have been advertised longer and are better known there than in the West. It is therefore hoped that this paper will stimulate to some extent the interest that has recently been aroused on the Pacific Coast.

Many small installations have been made through the efforts of individuals and these will be valuable as basis for extensions and they can be tied together to form larger installations. A highway lighting demonstration was an important part of the All-Western Road Show Nov. 9 to 14, 1925. As a result the State Highway Commission will make a trial installation near Tracy. This will be watched with keen interest as it is the first step toward including lighting as a necessary part of highway construction and maintenance.

Power company interest has been shown by the Pacific Gas and Electric Company demonstration soon to be installed just south of San Francisco.

Various types of highway units are included and lighting results can be compared. Also the arrangement is such that 150-ft. and 300-ft. spacings can be compared and the lighting of curves can be demonstrated.

The demonstrations being made will unquestionably go far toward educating the motoring public, public officials, automobile clubs and central stations and thus gain the necessary support that eventually will make every highway in the West as safe and convenient at night as by day. What greater service can we of the electrical industry render our community, our fellow citizens and ourselves?

Recent Developments and Recommendation for Proper Street Lighting*

Previous committees have done a great deal of work and have covered the subject of street lighting very thoroughly. These previous papers have been successful in selling the idea of better street lighting. Therefore it will be necessary to devote very little of this paper to selling the value of street lighting to the central station.

A few years ago street traffic was slow and few people were out after dark. Obviously street lighting that was adequate in those days does not meet the requirements of high speed traffic and the increased nocturnal activity of today.

The moving picture and the automobile are largely responsible for the increased use of city streets at night. In our larger cities millions of dollars are invested in moving pictures and automobiles and in our smaller communities proportionate sums are invested, while a few years ago there was no expenditure at all. Modern street lighting is a ncessary part of the higher standard of living, represented by the universal use of the automobile and increased expenditure for amusement and education.

The value of high intensity lighting in business districts has become generally recognized by business men and owners of business property. Most cities and towns therefore have fairly well lighted business streets, and those who haven't will not lag behind very long because of the active interest being shown everywhere by business and civic improvement organizations.

It is therefore safe to say that business streets will get their share of the street lighting appropriation, and in proportion to taxes paid they should get a large share. There is danger, however, that residential streets and traffic arteries may be neglected in an effort to light the business district without materially increasing the street lighting expenditure per capita. Considering the increased street lighting as a necessary part of our higher standard of living and necessary for public safety and convenience, the increased expenditure necessary to light properly all classes of streets, appears insignificant, especially when compared with the enormous increase in expenditures for automobiles, amusements, better homes, police, fire and health protection, parks, municipal buildings, etc.

The amount per capta per year a city or town will have to pay for properly lighting all of its streets depends somewhat on its size, density of population, traffic conditions and layout of streets. However, the following table shows the average yearly per capita expenditure based on the experience of well lighted cities throughout the United States:

Population	Per Capita per Year
Less than 5,000	$2.50
5,000 to 20,000	2.00
20,000 to 100,000	1.75
Over 100,000	1.50

These figures are approximate and intended only as a guide. The actual amount any city should spend must be determined by first formulating a plan. The first step is to secure a large map of the entire city and lay out the streets in accordance with the following subdivisions:

I—Principal Business Streets
II—Secondary Business Streets
III—Main Traffic Arteries
IV—Secondary Traffic Arteries.

* Report of Street Lighting subcommittee: K. M. Koch, General Electric Company, chairman; R. F. Conlisk, Westinghouse Electric & Manufacturing Company.

V—Residential Streets and Park Drives
VI—Alleys.
VII—Manufacturing and Wholesale Districts
VIII—Highways and Undeveloped Districts

The above applies, of course, to a large city. However in laying out a plan for a smaller community the method is the same except certain classifications will not be used and the problem is therefore simplified in proportion to the size of the city. Where a city plan is available it should be used as the basis for the street lighting plan. If not available the street lighting map necessarily becomes the city plan. It is important to have the advice of city planning experts in connection with this work.

After the streets have been clasified the next step is to specify the quantity of light for each classification. Lumens per linear foot of street have been generally accepted as the proper basis on which to classify the different degrees of street illumination. Table I gives general recommendations for ornamental street lighting and shows both the minimum and the most desirable lumens per foot recommended. It should be kept in mind that these classifications and recommendations are for cities of 100,000 population or larger and in the small city the main business street would be classed as secondary business in

TABLE I—GENERAL RECOMMENDATIONS FOR ORNAMENTAL STREET LIGHTING

Class of Street	Available Lamps	Mounting Height feet	Feet of Street per standard	Lumens per foot of street
Intensive White Way Arc Lamps	6.6 ampere luminous 15,000 and 25,000-lumen Mazda lamps	18–25	50– 75	300–800
White Ways	6.6 amp. luminous arc lamps			
Principal business streets	10,000 and 15,000-lumen Mazda lamps	14–16	40– 65	200–400
White Ways	6.6 amp luminous arc lamps			
Secondary bus. streets	6,000, 10,000 and 15,000-lumen Mazda lamps	14–16	40– 65	125–250
Main Thoroughfares	4,000, 6,000 and 10,000 Mazda lamps	14–16	50– 75	80–150
Secondary Thoroughfares	2,500, 4,000 and 6,000-lumen Mazda lamps	12–14	50– 75	50–80
Residential streets, Boulevards and Park Drives	2,500 and 4,000-lumen Mazda lamps	11–14	60–100	25–50

TABLE II—RECOMMENDATIONS FOR OVERHEAD STREET LIGHTING

Class of Street	Size Lamp	Mounting Height Feet	Feet of Street per Lamp	Lumens per foot of Streeet
Main Thoroughfares	6,000 and 10,000-lumen Mazda lamps	15–25	75–150	80–150
Secondary Thoroughfares	2,500, 4,000 and 6,000-lumen Mazda lamps	15–25	75–150	35–80
Main Residential, Apartments and Wholesale District	2,500 and 4,000-lumen Mazda lamps	15–25	75–200	25–50
Secondary Residential	1,000 and 2,500-lumen Mazda lamps	15–20	100–200	10–25
Highways, Alleys and undeveloped sections	2,500-lumen Mazda with Highway unit	30–35	300–400	6–8

the larger city. Likewise the smaller city main thoroughfares should be considered as secondary. Residential streets if important enough to have ornamental lighting would be the same whether in a small or large city.

Outside of the business district, however, practically all lighting will be overhead. Table II of recommendations will serve as a guide.

It will be noted that slightly lower minimum lumens per foot of street are allowed for overhead lighting as compared to ornamental standards. This is possible because the pendant fixture with reflector or refractor delivers more of the available light down upon the street surface. In specifying the lumens per foot for any class of street it is important to use large lamps at the maximum spacing if necessary rather than use small lamps at the minimum spacing. By using large lamps a given amount of light can be secured for less money because large lamps are more efficient in lumens output per watt and a smaller number of large units means less maintenance than a large number of small units. In this connection it is recommended that no lamp be used smaller than 2,500 lumen, until every street intersection is provided with at least a 2,500-lumen lamp. The 1,000-lumen lamp may be used in the middle of the block in secondary residential sections where a light is needed and funds are not available for a 2,500-lumen lamp.

After determining the quantity of light the next step in formulating the plan is to select fixtures that will best meet the requirements. In the selection of lighting equipment perhaps the main items to consider are costs, appearance, illumination and depreciation. Table III shows in more detail what goes to make up these items and suggests weighing factors that might be used if an accurate comparison of serveral systems is to be compiled for a main traffic artery.

Table III

Basis for Comparison of Ornamental Street Lighting Systems for Traffic Arteries in Per Cent

Costs	30	Installation		15
		Operation and maintenance		15
Appearance	30	Daylight—standard and fixture		10
		Night—of fixture		10
		General—of entire street at night		10
Illumination	30	Ability to see	20	On street 8
				At street intersection 3
				On intersecing street 3
				On sidewalk 2
				House numbers 2
				Between houses 2
		Absence of glare	10	From street 6
				From sidewalk 2
				From house 2
Depreciation	10	Ability to stay clean		5
		Ability to stay in adjustment		5

Figures indicate percentage allotment or weighing factor for each fixture. Each item should be rated on a scale of 100 with regard to each characteristic. A final rating will then be derived by multiplying the rating of each characteristic by its weighing factor given in the above table and dividing by 100.

Some changes in weighing factors would be necessary for other classes of streets. Usually, however, an accurate comparison is not necessary if the selection is to be made by one with some experience in judging lighting systems.

Table III may be regarded as advice in the selection of equipment. Judgment should not be passed on only a few samples as it is the cumulative effect of a long line of lights that really counts. Installations of modern illuminants usually are available in nearby cities and it is far less expensive and more satisfactory to visit such installations for comparison than to attempt to duplicate them on a small scale in your own city.

One of the main advantages of a street lighting plan is the opportunity it affords for selecting standards and fixtures varying in size and output, but similar in design. Thus when the plan has been fully carried out the street lighting equipment is uniform in design, giving the streets a neat, orderly appaerance. All of the best designs of ornamental fixtures and standards are now available in several sizes making up what is known as an "Architectural Family" of standards.

Of particular interest to the central station is the problem of furnishing satisfactory ornamental lighting without the necessity of underground construction. This has been met in many cases with entire satisfaction to all by the use of the ornamental trolley pole bracket. An example of this type is shown in Fig. 1. This has also been used on power company wood poles. Los Gatos is an example of this type of ornamental lighting. Twenty-five brackets are installed with the latest type of glassware and 10,000 lumen lamps.

Recent Developments

Practically all new installations are using the rippled or rectilinear type of glassware which has practically superceded the old style opal glass. This new glassware with its surface broken up into tiny hills and valleys has several important advantages

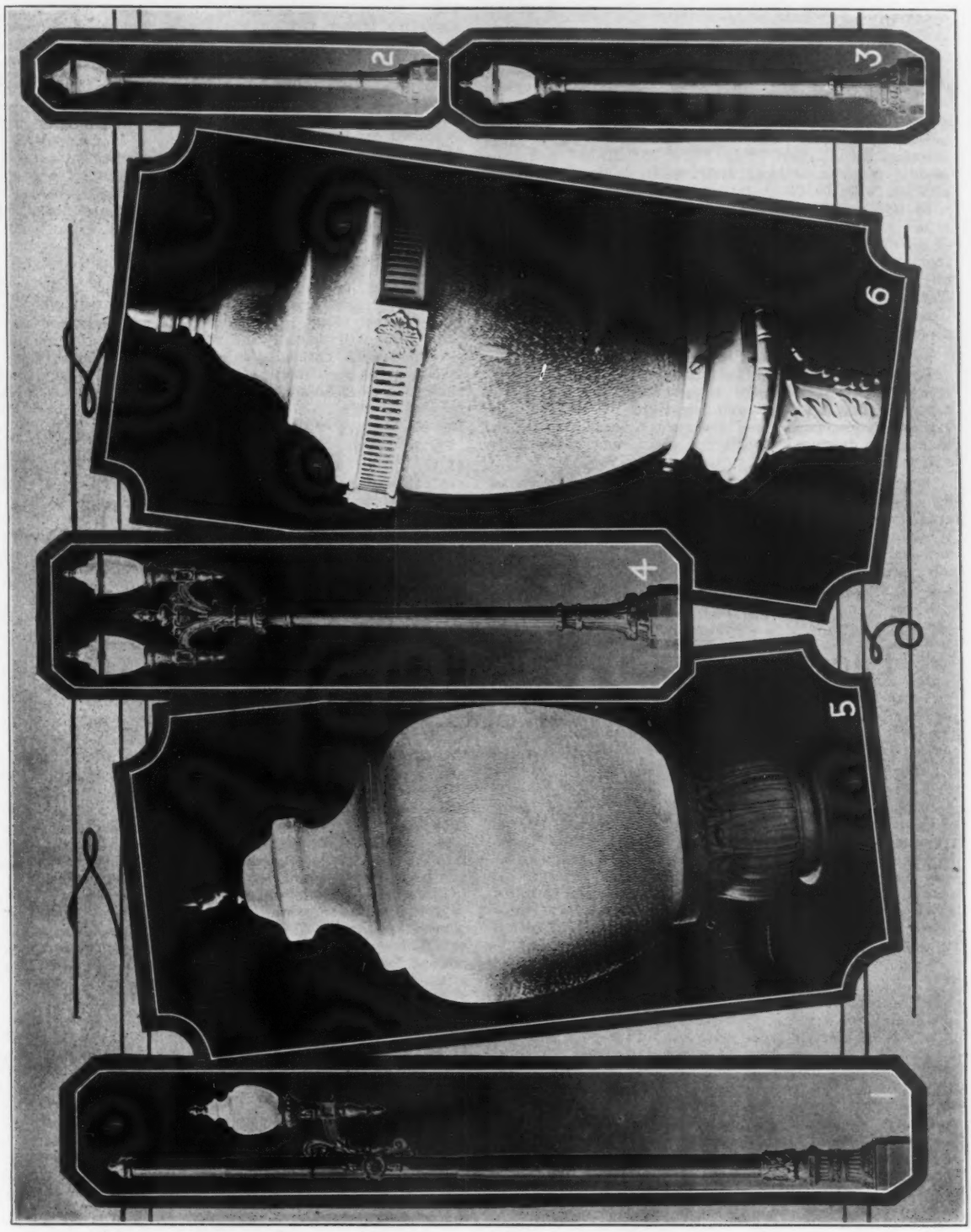


Fig. 1. Recent types of street lighting standards and luminaires. 1—New ornamental trolley bracket. 2, 3, and 4—Architectural family of standards. 5 and 6—New designs of street lighting luminaires made in several sizes for architectural families of standards.

over the smooth surface opal glass. Briefly these are as follows:

1. Less absorption of light. Light is diffused by uneven surface of glass rather than by opaque opal substance.
2. Sparkling appearance more pleasing both by day and by night.
3. Permits the use of refractors giving various types of light distribution.
4. Easy cleaning. Rain does not streak globe but dirt settles in ridges and is carried away.

Of the thousands of ornamental units being installed in Los Angeles and vicinity practically all are equipped with this new type of glassware. In the northern part of the state there are also many new installations of this kind. A few notable examples are as follows:

1. Geary Street, San Francisco, from Mason to Van Ness Avenue.
2. Bancroft Way and other streets in Berkeley.
3. Palo Alto.
4. Napa.

5. Burlingame (Broadway and Burlingame Avenue).
6. Mt. View.
7. Vallejo.
8. Turlock.
9. Delano.
10. Santa Rosa.

In Berkeley, Napa and Mt. View refractors are used. In Berkeley the dome refractor giving a symmetrical distribution is used and the Bi-lux refractor giving an asymmetrical distribution is used in Napa and Mt. View.

In addition to the improved glassware several new types of refractors have been developed. These are of asymmetric type and are designed to re-direct light from the sidewalk and the upward hemisphere, into an angle below the horizontal on the street side. Asymmetric distribution is ideal for residential streets if used properly so as to eliminate sharp contrast and glare.

Overhead Lighting Practice

For pendant lighting the totally-enclosing, bowl-type refractor has practically superseded the open band type, because it is dust and bug-tight. Also dust collection on the bowl does not reduce the light output to such a degree as with the band, and cleaning is easier.

Another advance that has been made in overhead lighting practice is the use of rigid-bracket or mast-arm mounting in place of center-suspension units. When only very small lamps were available it was necessary to hang the fixture directly over the street intersection to secure any effective light. With the high intensity light sources used today better visibility is secured on the street when the lamp is mounted high or near the curb where it is out of the direct line of vision of the automobile driver. Rigid brackets or mast arms are recommended in place of center suspension for the following reasons:

1. Better visibility. Even when the unit is screened by tree foliage the light filters through and the freedom from glare is an advantage.

2. Better appearance of the fixture and of the entire street.

3. Ease of maintenance, because fixture does not swing in the wind.

Street Lighting Should be Planned

Referring again to the street lighting plan idea it is interesting to note that progress has already been made. San Francisco, Oakland, Berkeley and San Jose will install future street lighting in accordance with carefully laid out plans. Santa Cruz, Watsonville and Burlingame have recently relighted their entire residential districts in accordance with modern practice on the basis of a careful survey of the streets.

It is evident that street lighting has become one of the cities' major problems and one that offers the central station an opportunity to render service that will build good will and a desirable increase in load. This service apparently can best be rendered by means of a plan providing adequate lighting for all classes of streets and also providing for the use of larger lamps and extensions in the future.

Electric Truck Transportation Committee Report*

Review

The electric truck committee of the Commercial Section has continued, during the past year, to carry on a portion of the splendid work conducted by the transportation bureau during the preceding two years. However, because of the organization of a Transportation Section for a study of all phases of central-station transportation the question of the adaptability of electric trucks in such service, and in fact every factor entering into such application has been transferred to the newly formed Transportation Section.

1924 Report

In the reports of the tranportation bureau submitted in June, 1924, a comprehensive outline of the development of the electric truck with its future potentialities was made. In these reports particular stress was laid upon the highly desirable class of revenue which would accrue to central stations from the further use of the super-electric appliance. These reports stressed the necessity of maintaining accurate cost data and also specifically urged that in furthering the sale of this appliance a special consideration should be given by central stations to its adaptability.

Incorporated in these reports were several comparative cost analyses which, while of unusual interest, might possibly have been misleading because of variation in cost accounting methods.

1925 Report

In the 1925 report of the transportation bureau it was decided definitely to eliminate any comparative cost data; to the users of electric trucks the economies had been definitely established and it was thought that further cost data publication might tend to confuse the issue in the minds of prospective purchasers.

It has been paramount in the minds of the members of the committee compiling the 1925 report, also that it was primarily important to convince the power companies of the possibilities which the electric truck offered for their own uses. With this thought in mind a considerable amount of technical data, from an operating standpoint, was incorporated in the report. At the same time it was pointed out to the power companies that to a large extent the general acceptance of the electric truck, by the transportation using public, was contingent upon the transportation policy adopted by the power companies.

With these thoughts in mind a series of letters was prepared and forwarded to central station executives, as well as to the heads of the sales and operating departments. Considerable time and thought were devoted to this series to the end that each letter should make a proper appeal to each of the three classes referred to.

1926 Activities

Subsequent to the preparation of last year's report of this committee the following activities may be chronicled:

Electric Truck School

An electric truck school was held in San Francisco just prior to the N.E.L.A. convention in June. This school was well attended, with a daily average of 35 and included representatives from Portland, Los Angeles and San Diego, as well as points adjacent to San Francisco. Representatives from many eastern factories were present and considerable impetus has been since felt as a result of this school. Both the street truck and industrial truck and tractor were well covered by the faculty.

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* **H. H. Singletary**, Pacific Gas and Electric Company, chairman. **L. F. Boerner**, Electric Storage Battery Company, vice-chairman. **W. J. Walsh**, Great Western Power Company, secretary. **Mercury Manufacturing Company:** A. J. Anderson. **Canavan Motor Company:** J. J. Canavan. **Commercial Truck Company:** K. I. Dazey. **Westinghouse Electric & Manufacturing Company:** H. D. Easterbrook. **Philadelphia Storage Battery Company:** H. A. Fore. **Western States Gas & Electric Company:** H. K. Griffin. **General Electric Company:** D. D. Henion, Ed. Hunt. **Electric Storage Battery Company:** E. Kower. **San Joaquin Light & Power Corporation:** M. P. Lohse. **Ward Motor Vehicle Company:** L. L. Morgan. **San Joaquin Light & Power Corporation:** J. S. Moulton. **Elwell-Parker Electric Company:** I. G. Perrin. **San Diego Consolidated Gas & Electric Company:** P. P. Pine. **Southern California Edison Company:** C. R. Spurling. **Edison Storage Battery Company:** G. F. Wakeman. **Auto Car Sales Company:** A. Walthew. **Los Angeles Gas & Electric Corporation:** W. W. Willitts.

The school was ably conducted under the personal supervision of C. R. Skinner, Jr., of New York City.

San Francisco Electrical Development League Luncheon

On the opening day of the electrical truck school a special luncheon, devoted to electric trucks was held, with an attendance to excess of 400. The meeting was addressed by A. E. Wishon, vice-president and general manager of the San Joaquin Light & Power Corporation, who delivered an excellent talk on the advantages of battery charging load to the central station and hammered home the necessity for power company support, both in use of trucks as well as in sales assistance.

Mr. Wishon "took off his gloves" and drove home fact after fact in a way which met with hearty, splendid and well deserved applause.

Electric Truck Parade

Immediately following the electric truck luncheon a street parade of some eighty electrics, passed the hotel in which the luncheon was held, rounding out Mr. Wishon's talk and picturing to the electric fraternity the fact that there are already many electric trucks in operation in San Francisco, and at the same time "selling the idea" of possible future development. To many the parade was an eye-opener.

N.E.L.A. Electric Truck Luncheon

Through co-operation with the N.E.L.A. we were able to arrange for an invitational luncheon for central station executives during the June convention. The luncheon was well attended, over 200 being present, including many of the outstanding executives of the largest power companies in the United States. Arthur Williams, vice-president of the New York Edison Company, delivered a splendid talk on the building up of battery charging load and then called upon several of the executives present for expressions of opinion. This resulted in many declarations of future policy on the part of the power company executives concerning electric truck use and promotion, the effect of which will no doubt make itself felt throughout the entire country.

Legislative Matters

Through the co-operation of the Electric Transportation Association a reduction in the state license fees on electric trucks has been obtained as follows:

½ and ¾-ton trucks	65 @ $20 each	$1,300.00
1-ton trucks	248 @ 15 each	3,720.00
2-ton trucks	134 @ 20 each	2,680.00
3½-ton trucks	23 @ 10 each	230.00
5-ton trucks	9 @ 10 each	90.00
Approximate annual saving to owners of 479 trucks		$8,020.00

The above tabulation excludes all electric trucks owned by public utilities which do not pay any license fees under our state law.

The association, through its attorney, has carried on a fight in the courts to have declared unconstitutional taxes previously levied against electric trucks. While the decision of the lower courts was unfavorable, and the state supreme court denied a rehearing, the action, we believe, will have a salutary effect on any proposed future legislation.

1926 Sales

At the preparation time of the last report there were in use in the state of California 930 street and industrial trucks and tractors. This has been increased by the sale of 98 trucks and tractors during the period covered by this report, which is slightly in excess of 10 per cent.

Educational Letters

This committee felt that the work of its predecessors largely covered central station usage, and it was believed that by means of an appeal to other prospective users, in various commercial lines, our field of activity might be enlarged considerably.

Working along these lines a comprehensive analysis of the logical prospective users of industrial trucks and tractors was made. From this survey has been secured a very active list of actual prospects. The same procedure has been followed with electric street truck prospects and a series of letters, addressed to the executives of these companies, outlining the purposes of the Pacific Coast Electrical Association and the particular functions of this committee, have been prepared and sent out to 400 prospective industrial truck and tractor users and 350 prospective electric street truck users. These letters, which are appended to this report, consist of a series of seven letters to each of the two classes. It will be noted that these letters are predicated upon the broad ground of offering assistance in analyzing transportation problems and that they are purely of noncontroversial character.

Retarding Factors

Various developments in the last few years, particularly insofar as the local territory is concerned, have tended to retard the sale of electric trucks. Most of these conditions will rectify themselves.

In many of the logical fields of electric truck application commodity price wars have been in effect. Through eventual consolidation and stabilization these very industries are changing their transportation conditions to the point where ultimately the electric truck will be accepted as the most adaptable transportation equipment.

Conclusions

In conclusion, this committee feels, while the development of electric transportation may be comparatively slow at present, that it may express its confidence, nevertheless, in the ultimate future of the electric truck in this territory. To a large extent, however, this will depend upon the continued recognition and support of the central stations, both in their own usage and in sales promotion. The former results in minimizing sales resistance, imbues the truck salesman with added confidence and helps him to continue in his efforts to add other electric trucks to central station lines. Furthermore, with respect to sales assistance, a representative from a power company can approach a prospective user of electric trucks from the standpoint of a desire to render a service; consequently he is granted a more respectful audience and can more quickly gain the confidence of the power company's customers. That this is essential in the realization of a volume of sales of electric energy for charging batteries is thoroughly borne out by the experience of the eastern central stations.

Recommendations

For reasons already explained we again urge upon central-station executives, and operating, automotive and sales department heads, a serious consideration of the electric truck, as it must be through the active assistance of power company officials that we may look forward to substantial additions to battery-charging revenue.

We concur in the recommendations of the Society for Electrical Development for central stations, as follows:

1. Effective co-operation: (a) Have at least one man in the central station organization who is charged with the responsibility of developing electric truck business. (b) Have the power salesman talk electric trucks.
2. Include electric truck copy in the budgets for advertising (newspaper, direct-mail, etc.).
3. Include articles on delivery and electric trucks among data and information sent to local newspapers.
4. Recommend that central stations do not act as dealers for electric trucks.
5. When a man buys electric trucks, expedite the installation of electrical service.
6. Establish right off-peak power rate for charging electric trucks.
7. Increase public electric truck garaging and charging facilities.
8. Remove obstacle to electric truck sales due to cost of charging equipment by furnishing necessary equipment for converting alternating to direct current on a rental basis or including cost of it in charge for current or by arranging for purchase of it on deferred payment terms.
9. Use electric trucks themselves wherever applicable and use no other types of vehicles for their own service until definite investigation proves that the work cannot be performed satisfactorily by the electric.

Letters

Following are the letters sent out to prospective electric truck customers:

Street Truck Series

Millbrae Dairy,
855 McAllister Street,
San Francisco, Calif.

Attention: Mr. Frank Robb.

Dear Sir: The Pacific Coast Electrical Association is composed of central station companies, electrical manufacturing companies and kindred interests. Its object is to foster scientific research into the various branches of the electric industry.

The association has delegated a committee of its members to investigate electric truck transportation and the results of the efforts of this committee are to be made available to all interested industries. The object of this letter and the series to follow is to call your attention to the results revealed by the work of this committee.

The Naional Electric Light Association, with which the Pacfic Coast Electrical Association is affiliated, is the largest organization of its character in the world. Its standing is such as to warrant your serious consideration of the facts which will be presented to you.

Yours very truly,

H. H. SINGLETARY,
Chairman, Electric Truck Committee,
Pacific Coast Electrical Association.

"Electric Fleets for City Streets"

Millbrae Dairy,
855 McAllister Street,
San Francisco, Calif.

Attention—Mr. Frank Robb.

Dear Sir: Mr. Bryan decided the question of evolution of man.

Evolution of transportation is of vastly more importance to the present-day business man.

1803 Fulton developed his first steam engine.
1804 First practical locomotive developed in England.
1899 Motor trucks first used in transportation.
1910 3,255 gasoline trucks, value $4,500,000.
1914 World War.
1915 25,375 gasoline trucks, value $45,000,000.
1919 316,000 gasoline trucks, value $465,000,000.

Emergency Act taking over railroads during the war forced purchase of gasoline motor trucks, which were capable of long hauls, to supplement inadequate railroad transportation.

Psychology of buying; continued purchase of gasoline trucks for congested districts.

PRESENT

Horses and gasoline trucks used in congested districts, causing costly congestion.

REMEDY

City ordinance taking horses out of congested districts. Quick accelerating electric trucks for short hauls and frequent stops in congested centers at 40 per cent less transportation cost.

Yours very truly,

H. H. SINGLETARY,
Chairman, Electric Truck Committee,
Pacific Coast Electrical Association.

"Electric Fleets for City Streets"

Millbrae Dairy,
855 McAllister Street,
San Francisco, Calif.

Attention—Mr. Frank Robb.

Dear Sir: Of the many items which go to make up "overhead," that of taxation is one of the most important.

While we may at times desire a more business-like handling of our national, state and municipal affairs, the fact remains that increased population and particularly population congestion is largely the basis of increased cost.

Seventy per cent of the police force is used for traffic.
Millions of money is being spent to hasten movement.
Delayed traffic passes back incalculable economic loss.

SOLUTION

Quick accelerating electric trucks for congested districts at 40 per cent less cost.

Yours very truly,

H. H. SINGLETARY,
Chairman, Electric Truck Committee,
Pacific Coast Electrical Association.

"Electric Fleets for City Streets"

Millbrae Dairy,
855 McAllister Street,
San Francisco, Calif.

Attention—Mr. Frank Robb.

Dear Sir: During that period of 1920 and 1921, aptly termed the Reconstruction or Retrenchment period, every executive gave his personal attention to the fundamental basis of merchandising, namely, manufacturing and selling, with the necessity of reducing costs.

Did you give personal attention to your deliveries, or did you allow a subordinate to dictate that feature?

The profit of every article is increased or decreased by efficient or inefficient delivery service.

Goods delayed in transit represent frozen credit.

This important question needs your attention.

SOLUTION

Electric trucks are doing this for others.

Yours very truly,

H. H. SINGLETARY,
Chairman, Electric Truck Committee,
Pacific Coast Electrical Association.

"Electric Fleets for City Streets"

Millbrae Dairy,
855 McAllister Street,
San Francisco, Calif.

Attention—Mr. Frank Robb.

TRUCKS OR TRANSPORTATION

Dear Sir: When you require additional or replacement delivery units, which do you buy—Trucks or Transportation?

Is the selection or equipment based upon—
Reciprocal relations
Personal friendship
High-Pressure salesmanship, or
Driver Preference?

Comparatively few transportation users analyze their hauling problems from the standpoint of adaptability.

Our expert will analyze your delivery service and render an impartial report to you.

Electric trucks are a "tailor-made" fit for city hauling.

Yours very truly,

H. H. SINGLETARY,
Chairman, Electric Truck Committee,
Pacific Coast Electrical Association.

"Electric Fleets for City Streets"

Millbrae Dairy,
855 McAllister Street,
San Francisco, Calif.

Attention: Mr. Frank Robb.

Dear Sir: In city deliveries, the higher maximum speed of the gasoline vehicle does not mean faster transportation; frequent delivery or traffic stops result in a higher average for the electric —more miles per day. In addition to this, it is a fact that frequent stop work not only increases the gas consumption several fold, but causes gasoline to go into the crank case and decreases the life of the gasoline motor in direct proportion.

Another feature is that owing to the easy movement and easy acceleration, an electric truck driver is much more efficient from a physical standpoint at any time during the day than with either horse or gasoline vehicles.

In the event you have not analyzed this potential saving in your delivery system, we recommend that you communicate with us in order that we may survey your hauling problem without obligation on your part.

Yours very truly,

H. H. SINGLETARY,
Chairman, Electric Truck Committee,
Pacific Coast Electrical Association.

"Electric Fleets for City Streets"

Millbrae Dairy,
855 McAllister Street,
San Francisco, Calif.

Attention: Mr. Frank Robb.

Dear Sir: In city deliveries, the higher maximum speed of the estimated when each route or hauling problem is figured on conditions of operation.

To state that the electric truck is more economical for all hauling and delivery purposes would be both ridiculous and untrue—BUT

If your deliveries come within the frequent stop class or if they are in the congested area, we say to you in no uncertain terms that the electric truck will effect substantial savings in your transportation costs as compared with gas truck deliveries. They will speed up your deliveries at the same, or less, cost as compared with horse-drawn vehicles. And public sentiment and sanitation are fast ruling the horse off the street.

A study of your conditions will enable us to tell you **how much electric trucks will save you.**

Yours very truly,

H. H. SINGLETARY,
Chairman, Electric Truck Committee,
Pacific Coast Electrical Association.

"Electric Fleets for City Streets"

Industrial Truck Series

McCormick Steamship Company,
Matson Building,
San Francisco, Calif.

Attention: Mr. Henken.

Dear Sir: The Pacific Coast Electrical Association is composed of central station companies, electrical manufacturing companies and kindred interests. Its object is to foster scientific research into the various branches of the electric industry.

The association has delegated a committee of its members to investigate electric transportation and the results of the efforts of this committee are to be made available to all interested industries. The object of this letter and the series to follow is to call your attention to the results revealed by the work of this committee.

The National Electric Light Association, with which the Pacific Coast Electrical Association is affiliated, is the largest organization of its character in the world. Its standing is such as to warrant your serious consideration of the facts which will be presented to you.

Yours very truly,

H. H. SINGLETARY,
Chairman, Electric Truck Committee,
Pacific Coast Electrical Association.

"Electric Fleets for City Streets"

McCormick Steamship Company,
Matson Building,
San Francisco, Calif.

Attention: Mr. Henken.

Dear Sir: It can be demonstrated to the satisfaction of any reasonable person that the Pyramids of Egypt and other similar monuments of antiquity could not have been constructed without the aid of mechanical devices. This, in spite of the fact that human labor was available at little or no cost, in unlimited quantities.

The entire story of the phenomenal rise of modern successful enterprises is that of the adoption of the latest types of motion saving, time saving, space saving and effort saving mechanical devices. There is no record available, for instance, of any large enterprise having abandoned the use of the extremely efficient industrial electric truck where it had once been used.

Yours very truly,

H. H. SINGLETARY,
Chairman, Electric Truck Committee,
Pacific Coast Electrical Association.

"Electric Fleets for City Streets"

McCormick Steamship Company,
Matson Building,
San Francisco, Calif.

Attention: Mr. Henken.

Dar Sir: Once upon a time a man with a progressive brain took a box with two handles, put a wheel underneath and moved more bricks per hour than had ever been done by anyone before in history. Somebody dubbed it a wheelbarrow, but it worked. The wheelbarrow has survived because it represented improved efficiency over cruder forms of handling goods.

Industry now makes use, where efficiency is held in esteem, of every known practical method of expediting the movement of merchandise, whether within a warehouse or from dock to steamship, truck to railway car, or even across the continent. These devices take the form of belt conveyors, chutes, express trains and even airplanes.

The standard device for moving material and merchandise over comparatively short distances, where floors are fairly smooth, is THE ELECTRIC INDUSTRIAL TRUCK. This is especially true in situations where dependability, space, and labor costs are important items.

Yours very truly,

H. H. SINGLETARY,
Chairman, Electric Truck Committee,
Pacific Coast Electrical Association.

"Electric Fleets for City Streets"

McCormick Steamship Company,
Matson Building,
San Francisco, Calif.

Attention: Mr. Henken.

Dear Sir: The man who pays the bills is usually the hardest to convince as to better or more economical means of handling material. The executives of all organizations are busy men, altogether too busy to get around to see what many other companies engaged in the same general line of business are doing.

There are very few jobs of handling material by man power where mechanical methods cannot be employed with proved economies.

In former days it required two men to steer a ship by hand, today they are steered by power. This same condition existed where hand hoists were used. Today power hoists take the place of man-power, saving time and expense. The same improvement marks the handling of materials on docks and in warehouses, where the modern electric truck or tractor effects savings of from 25 to 75 per cent in man power costs.

These definite savings warrant the earnest consideration of every business executive.

Yours very truly,

H. H. SINGLETARY,
Chairman, Electric Truck Committee,
Pacific Coast Electrical Association.

"Electric Fleets for City Streets"

McCormick Steamship Company,
Matson Building,
San Francisco, Calif.

Attention: Mr. Henken.

Dear Sir: We cannot foretell the exact amount of pay-roll savings that can be effected by the mechanical handling of your materials, but a thorough survey of your plant will enable the submission to you, of an accurate and interesting statement of savings.

The electric industrial truck and tractor are manufactured in sizes and types to meet practically every plant condition, in fact there is an industrial truck or tractor to fit almost every conceivable condition, irrespective of width of aisles, radius of turns, inclines, etc.

Manpower costs money, and it requires less men to operate electric industrial trucks and tractors than any other method of handling material.

May we survey your problem without expense to you and without obligation on your part?

Yours very truly,

H. H. SINGLETARY,
Chairman, Electric Truck Committee,
Pacific Coast Electrical Association.

"Electric Fleets for City Streets"

McCormick Steamship Company,
Matson Building,
San Francisco, Calif.

Attention: Mr. Henken.

Dear Sir: Constantly increasing speed seems to be the requirement of the day, whether it be in the transmission of mails, passenger travel, or the transportation and handling of freight, local or long distance.

For instance, in Los Angeles several months ago, horse-drawn vehicles were ruled from certain congested streets during certain hours. The principal reason for this was to speed up traffic movement, because of the ability of motor traffic to move at higher speeds.

Because of the same demand for increases of speed, as well as greater efficiency in industry, all man-power methods of moving materials are no longer satisfactory and in many instances, not even possible.

Modern mechanical methods of handling materials have been the solution to this new requirement; electric industrial trucks traveling at three to five times the speed of men and moving from six to twenty-five times the volume per load, meet these requirements for speed and economy.

Yours very truly,

H. H. SINGLETARY,
Chairman, Electric Truck Committee,
Pacific Coast Electrical Association.

"Electric Fleets for City Streets"

McCormick Steamship Company,
Matson Building,
San Francisco, Calif.

Attention: Mr. Henken.

Dear Sir: We have been calling your attention, in the letters preceding this one, to an extended investigation which the Pacific Coast Electrical Association has been carrying on with regard to the present-day requirements relative to the handling of materials in industries.

The result of this research discloses, that due to the shortage of common labor and the highly competitive condition found universally, only in those industries where efficient mechanical material handling methods are utilized is profitable operation possible.

Our survey further shows that in California there are over 400 electric industrial trucks, tractors, crane trucks and special types of trucks serving the following industries to reduce handling costs:

Automobile and tractor factories.
Clay products factories.
Fruit packers and sugar refineries.
Grain and milling industries.
Lumber industries.
Mining.
Oil refineries.
Ship yards.
Manufacturers, jobbers.
Steel and metal products.
Terminal, freight, express, etc.

In conclusion: Executives of above industries report a direct saving of 25 to 50 per cent on handling costs of commodities in their respective businesses by the use of Electric Industrial Trucks and Tractors. This warrants your interest and investigation.

Yours very truly,

H. H. SINGLETARY,
Chairman, Electric Truck Committee,
Pacific Coast Electrical Association.

"Electric Fleets for City Streets"

Power Committee Report*

The activities of the bureau this year have been somewhat different from previous years in two respects, first, there have been no papers prepared, and second, the bureau confined its work to one problem, namely, industrial electric heating.

The bureau felt that it could best serve the industry by acting as an influencing agency to create a greater and broader interest in the possibilities of industrial heating as a remunerative activity to the industry, and as an advance service to the public. We have carried on three major activities:

First, calls were made upon the executives of the utilities to give them first hand information on what a greater industrial heating load would mean to them in the way of increased load, improved load factor, improved diversity factor, and specific data have been put into their hands as regards many of the interesting and outstanding installations of electrical industrial heating that have already been installed on the Pacific Coast.

Some of the executives were already cognizant of these things and had put on their payroll special power solicitors to exploit this particular kind of business. It was found that other executives had not been inspired to do anything specific along this line, and it is hoped that the visits of committeemen will result in greater activity.

We have brought to the attention of the executives of the power companies the fact that there is in existence in the spring of each year, a two weeks' industrial heating school conducted in the East, under the auspices of the N.E.L.A. These schools are held one year at the factories of the General Electric Company and the next year at the factories of the Westinghouse Electric & Manufacturing Company, and in addition, visits are made to conspicuous and outstanding installations. To date, the utilities on the Coast have never sent representatives to these schools, and we specifically urged that each utility send at least one representative to the school to be held this year at the factory of the Westinghouse company at Pittsburgh during May.

Some of the companies felt that a school should be organized for the Pacific Coast. This does not seem practicable, however, upon further analysis, due to the fact that there are less than 20 industrial heating specialists in the employ of utilities and manufacturers on the Pacific Coast, and as it is doubtful if all of these man would, or could, attend a two weeks' school, it was felt by the committee that we could hardly expect the ten or twelve eastern experts who give instruction at the school to come to the Pacific Coast. A short course for power solicitors generally, would hardly be worth while, as the subject is a highly technical one and can only be handled successfully with extremely careful analysis.

Second, lectures are being organized, some of which have already been given, in the interest of giving general information to the electrical industry at large regarding the possibilities of industrial electric heating and what has been done on the Pacific Coast, the idea being that the more people we could get interested in, and talking about the matter, the more rapid would be the development of this class of business.

Furthermore, by having lectures given before some of the industrial organizations outside of the electrical industry, we have available an opportunity for showing the industrial institutions how they can improve their products or effect economies in their production methods by employing electricity for this purpose. Very few people are aware of the advantages of carrying on industrial heating processes by electricity, as too frequently the only item given consideration is the cost of the fuel. As this report is being submitted, lectures had already been scheduled as follows:

San Joaquin Light & Power Corporation, Feb. 15.
Synchronous Club, March 30.
Joint Technical Societies, April 8.
A.I.E. Engineers, April 6.

Arrangements were being completed for additional lectures and it was hoped that before the annual convention in June many more meetings will have been held in different parts of the state.

Preparation of Reference Portfolio on Industrial Electric Heating.

Inasmuch as it was found that the various utilities did not have adequate information on the technique of industrial heating by electricity, and as no effort had previously been made to provide them with specific data and illustrations of Pacific Coast installations, it was felt that one of the most useful things we could do was to prepare a portfolio for reference purposes that would contain all this information.

In the limited time we had it was not possible to attempt to put out a formal and printed publication. We have, therefore, contented ourselves with preparing 25 copies of what might be termed an informal portfolio and is made up of data and photographs that are available in quantities of 25, from the various manufacturers of industrial electric heating apparatus and appliances. The portfolio is about 3 in. thick and depending upon the size of the utilities and the number of industrial heating specialists they have, the utilities will be given one or two copies of this. It will be leather bound and can act as a very excellent reference library, as it covers the subject very completely. The general character of the publication is as follows:

1. Heating Applications. A list showing all classes of commercial and industrial business with the possible heating applications.

2. Westinghouse Bulletin G-C. General Electric Bulletin. A general description of furnaces made.

3. Industrial Heating General.
   (a) Paper—Selling Electricity for Industrial Heating by E. J. Cipperly.
   (b) Industrial Heating for Factories. Wirt S. Scott. Reprint Westinghouse company.
   (c) Industrial Electric Heating. N.E.L.A. Report, 1924.
   (d) Electric Heat in Industry. General Electric company, 261.

4. Industrial Heating—Electric Bronze and Brass Melting.
   (a) Paper, Electric Bronze and Brass Melting. A. E. Wilcox.
   (b) Melting Bronze and Brass Electrically.
   (c) Photographs of installation, General U.S.
   (d) Photographs and data on installations, Southern California.

5. Arc Heating—steel.
   (a) Paper by E. V. Kane, 1925, with list of installations on Pacific Coast.

6. Industrial Heating—Enameling Ovens.
   (a) Electrically Heated Japanning Ovens. Wirt S. Scott. Reprint Westinghouse company.
   Low Temperature Electrothermal Process. Wirt S. Scott, Reprint Westinghouse company.
   Low Temperature Industrial Heating. Hershfield. Reprint General Electric company.
   Electrically Heated Ovens. Reprint General Electric company 48021-A.
   (b) Data and photographs on installations Southern California, by manufacturers.
   (c) Photographs of other installations by manfacturers.

The data and photographs of installations are to be separated into groups for the different classes of work, and in the industries they are installed.

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* **F. E. Boyd**, General Electric Company, chairman. **Pacific Gas and Electric Company:** John Farley. **Butte Electrical Equipment Company:** Felix Butte. **Westinghouse Electric & Manufacturing Company:** T. A. Reid, Max Lee. **San Joaquin Light & Power Corporation:** M. T. Lohse. **General Electric Company:** E. J. Cipperly. **Southern California Edison Company:** A. A. Watson. **Los Angeles Gas & Electric Corporation:** Jack Wells. **Los Angeles Bureau of Power and Light:** E. V. Kane. **Swartout Company:** R. P. McKenzie. **Quality Electric Works:** T. A. Hunter. **San Diego Consolidated Gas & Electric Company:** P. P. Pine.

In similar manner core, baking, heat-treating and drying ovens will be covered.

While the present committee does not wish to be presumptuous in suggesting what future committees should do, at the same time, we take this occasion to express a feeling that we believe it would be of advantage to the industry for succeeding committees to maintain the portfolios and add new and up-to-date data to them from time to time as it is available; otherwise, much of the value of this work will have been lost.

The power companies receiving the portfolios are as follows:

Pacific Gas and Electric Company	3
Great Western Power Company	1
Western States Gas & Electric Company	1
San Joaquin Light & Power Corporation	2
Bureau of Light and Power	1
Southern California Edison Company	2
Los Angeles Gas & Electric Corporation	1
San Diego Gas & Electric Company	1
The Southern Sierras Power Company	1
McGraw-Hill Company	1

*Transportation Section Reports**

Lubrication—A Study of Equipment and Practices

By E. B. WOOD and J. M. WAINSCOAT

In presenting this paper, we believe it is best to confine ourselves strictly to the practical aspects of engine and chassis lubrication, as these important factors must be dealt with in the field almost wholly from the personal experience of men who are called upon to determine what corrective measures must be utilized.

Lubrication

Lubrication is an agent that reduces friction. In some form or other it has been employed since time immemorial. In choosing between brands of lubricants made from different manufacturers, the users should be governed largely by the integrity and good name of the maker. The poorer grades of lubricants often break down or become fatigued with use and become gummy and hard, or emulsify. Many bearing failures can be traced to cheap grades of lubricants.

Mineral greases and oils only are suitable; for instance, for ball bearings, it has been found that vegetable oils easily decompose and become rancid and acid. Also, the lubricant must be neutral since free acids or alkali will attack and corrode the surface of bearings. Greases which become gummy, sticky, hard or contain abrasives, such as gravel, sand, lime, etc., should not be used. The cost of lubricant is such a small item that the best is none too good.

Submitting that correct lubrication is one of the most important single factors governing successful motor truck operation, the purpose of this paper is to show:

1. What correct lubrication is, and its relation to motor truck operation.
2. How motor truck operators can control correct lubrication.
3. Reasons why such control should be exercised.

What Correct Lubrication Is

Correct lubrication may be said to exist when all bearing surfaces of an engine are kept separated by a suitable lubricant, which substitutes internal friction of the lubricant for destructive metallic friction between bearing surfaces.

For the lubrication of internal combustion engines, pure oils possessing the proper characteristics are conceded to be the best. Correct lubrication can only be secured by:

(a) Using oils that possess all those characteristics or properties which make them adaptable to the needs of the engine in which they are used, and

(b) By exercising the necessary care and precaution in seeing that the necessary and proper oils are supplied to the engine in correct amounts and removed from the engine when contaminated to such an extent as to make their further use inadvisable. It is on account of a disregard for these two fundamentals that automotive equipment prematurely outlives its usefulness in a very short period.

How Motor Fleet Operators Can Control Correct Lubrication

It is a misdirected impulse in economy which prompts a desire for long oil mileage rather than correct lubrication, and causes some operators of automotive equipment to use oils too heavy in body to permit of correct lubrication, resulting in early destruction of bearing surfaces, and so short economic life is the answer. Correct lubrication, however, is not obtained by simply replenishing from time to time the oil supply in crankcases with a suitable lubricant. Lubricating oils when functioning as lubricants are detrimentally affected by engine operation by having mixed with them:

(a) Unburned fuel, which passes from the combustion chamber by the pistons and into the crankcase, where it becomes mixed with the entire oil supply, causing a loss of body in the oil and lessening its value as a lubricant in proportion to the amount of fuel present. Unburned fuel causes what is commonly called oil dilution and it lessens the lubricating value of an oil more rapidly in most cases than any of the others because generally it passes to the engine crankcase in larger amounts than the other contaminants.

(b) Water, which is the result of:

(1) Combustion of fuel,

(2) Sweating of the interior surfaces of the engine and crankcase,

(3) Leaking of water and cylinder head gaskets.

This water which finds its way to the crankcase becomes mixed with the entire lubricating oil supply and in combination with carbon, road dust and other impurities that find their way into the oil, causes a heavy deposit or sludge, which, if present in sufficient quantities, will cause damage to bearings by stopping the flow of oil through oil pipes and screens.

(c) Road dust, which enters through the breather pipe, or is drawn into the cylinders through the intake manifold and is deposited on the oil film on the cylinder walls and together with certain portions of the oil drops back into and becomes mixed with the main oil supply in the crankcase.

(d) Carbon, which is formed in the oil as the result of high temperatures of certain parts of the interior of the engine. Any one or all of the above contaminants renders a lubricating oil unfit for use in proportion to the amount present.

The Reasons Why Such Control Should Be Exercised

Frequent changing of crankcase oil gives a definite and positive control over correct lubrication and satisfactory truck performance. If this control is not exercised and the engine is permitted to operate with a diluted and contaminated oil supply, the result will be high cost of operation, due to repairs.

Under ordinary operating conditions, it is advisable and economical to change the entire supply in the motor crankcase after not more than 500 miles of operation. In instances where operating conditions are worse than the ordinary, that is, in extremely cold weather, or under very dusty conditions, crankcase oils should be changed at much more frequent intervals. This committee feels that no definite rule can be laid down other than the rule that oil should be changed every 500 miles, but we do feel, however, that it is safer and more economical to change oil too often than not often enough.

Lubricating oil has a useful life that is governed solely by the rate at which the contaminants are added to it, the lubricating value of the oil being lessened by the contamination and not by any change

* **S. B. Shaw**, Pacific Gas and Electric Company, chairman; **P. H. Ducker**, Southern California Edison Company, vice-chairman; **D. C. Bertrand**, Great Western Power Company, secretary. **California Oregon Power Company**: D. A. Runyard; **Coast Counties Gas & Electric Company**: A. E. Strong; **Coast Valleys Gas & Electric Company**: G. A. Peers. **Electric Storage Battery Company**: W. E. Gallimore. **Los Angeles Gas & Electric Corporation**: W. J. Schaeffer. **Pacific Gas and Electric Company**: Russell Mills, E. C. Wood. **San Diego Consolidated Gas & Electric Company**: C. D. Weiss. **San Joaquin Light & Power Corporation**: D. P. Mason (member ex-officio); J. S. Moulton, J. M. Wainscoat. **Southern Sierras Power Company**: C. H. Gray.

in the oil as a result of its specific functioning as a lubricant.

Why Engines Rust Inside

Corrosion in gas engines is believed to be due to the sulphur content in low grade fuels combining with water which enters or is formed in the engine, thereby producing sulphuric acid. Much of the trouble occurs in winter and may be traced directly to the action of water which condenses inside the cylinders, destroys the oil film and is deposited directly on the metal of the pistons and cylinder walls. Then the rusting or corrosion occurs, and if the lubricating system does not supply fresh oil immediately when the engine is started, scoring of the cylinders and pistons is likely to result. The only successful way of dealing with the condensation and rust problem is to provide a lubrication system that will start to function as soon as the engine is started.

TABLE I.—Lubrication Chart for applying the correct lubricant regularly and at definite intervals to the automobile chassis.

Element	Every Day	Every 500 miles	Every 1,000 miles	Every 2,000 miles
ENGINE PARTS—				
Oil reservoir	Examine or replenish with engine oil			
Fan Bearings	Engine oil or grease			
Valve Stems	Engine oil	..	..	..
Water Pump Bear.	Grease	..	..	..
Magneto	Engine oil	..	..	..
Electric Starter	..	Engine oil	Grease	
CLUTCH—				
Lever Bearings of foot pedal	..	Engine oil	..	..
Cone Clutch Bear.	..	Grease	..	..
Cone Clutch leather surface	..	..	Neatsfoot oil	..
Multiple disc clutch	..	..	Clutch oil	..
TRANSMISSION—				
Friction Drive	Engine oil	Grease	..	..
Gear Shift Lever	..	Engine oil	..	..
Gears	..	Gear oil	Grease	..
Planetary (Ford)	..	Oil supplied automatically by engine oiling system.		..
UNIVERSAL JOINTS—	..	Gear oil	Grease	..
DIFFERENTIAL—				
Gears	..	Gear oil	Grease	
CHAIN DRIVE—				
Driving Chains	Gear oil	..	Clean and soak hot tallow and graphite	..
Sprocket Bearings	Grease	..	..	..
STEERING GEAR—				
Knuckles	Grease	..	..	..
Rods	Engine oil	Grease	..	..
Worm & Sector	..	Grease or gear oil	..	..
Top of post	..	..	Engine oil	..
BRAKES—				
All Bearings	..	Engine oil	Grease	
SPEEDOMETER—	..	..	Grease	
SPRINGS—				
Spring end and shackle bolts	Grease	Engine oil	..	Grease
WHEELS—				
Front and Rear	..	..	..	Grease

A study of the preceding analyses of the construction and operation of automotive equipment requiring lubrication, together with the appreciation, care and attention which the same should receive, and the use of correct high grade lubricants regularly in an intelligent manner and according to some definite schedule of application will insure highest lubrication efficiency.

Oil should be applied with an oil can by hand or by a suitable apparatus that will handle oil. When gear oil is used for transmission and differential, it should be an oil of high lubricating efficiency which will cushion the gears, allowing them to engage easily and without noise, and will not congeal at low temperatures. Where grease is specified, care should be exercised in its selection. A correct grease for general service is one that is smooth, light in color and medium body, carefully strained in manufacture and free from all particles of insoluble and non-lubricating matter.

Prevailing policy as to changing crankcase oil is shown in Table II.

A gummed label reading "Change Oil at——Miles" is placed on the speedometer and this procedure works out very satisfactorily. All companies use this method for control.

Dilution

In order to test and determine the per cent of dilution by inspection, the committee finds that the "A" company has been carrying out some tests along these lines. Fig. 1 gives the dilution in per cent; readings are degrees Baume. The dilution chart was calibrated by first diluting the oil with gasoline and the readings taken and checked by the dilution apparatus. The working temperature was 60 deg. F. The dilution test apparatus utilized the Tagg method. It consists of using 100 c.c. of oil in a 259-c.c. distillation flask and heating it with a Bunsen burner. Steel wool is used as a filter in the neck of the distillation flask. The vapors pass through the steel wool filter into a 12-in. water cooled condenser and then into a special capillary funnel with a ½-m.m. bore into an open cylinder measuring 1/10 c.c. This test is correct to within 2 c.c. and fairly rapid in operation, taking only 10 minutes per sample.

TABLE II.—Mileage at which crank-case oil is changed.

Company	Passenger Equipment	Light Truck Equipment	Heavy Duty Equipment
(A) Pacific Gas and Electric Co.	750	750	500
(B) San Joaquin Lt. & Power Corp.	1,000	750	750
(C) Pacific Telephone & Tel. Co.	1,000	1,000	1,000
(D) Coast Valleys Gas & Elec. Co.	1,000	1,000	1,000
(E) Southern Sierras Power Co.	1,000	1,000	1,000
(F) Southern Calif. Telephone Co.	750	705	500
(G) Southern Calif. Edison Co.	750	500	300
(H) California Oregon Power Co.	750	500	300
(I) San Diego Cons. Gas & Elec. Co.	750	500	300

In order to determine by inspection, the chart was computed with a known per cent of dilution, which range of dilution was taken at intervals of 5, 10, 15, and 20 deg. and the gravity readings plotted on the curve. The solutions were again made up and checked with the dilution apparatus and at the maximum were out but 2 per cent. This was considered a close enough range of accuracy. This chart was only usable with this one grade of oil, so a general chart within the range of all paraffine and asphalt base lubricating oils on the Baume oil scale is in production. The results obtained with an oil agitation device and filters were given study also.

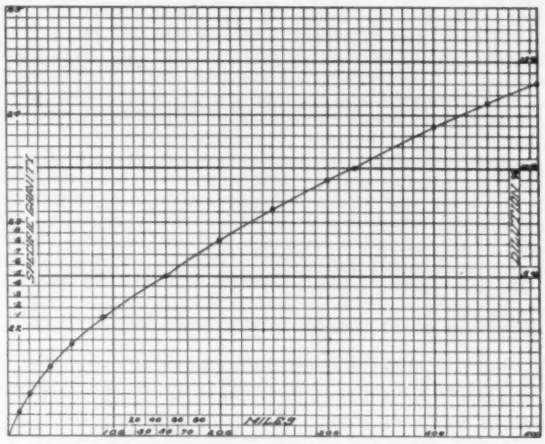


Fig. 1. Lubrication dilution chart showing the change in per cent dilution and the change in specific gravity plotted against the miles of service.

In winter weather with the street dirt being damp different conditions appear from which the data are not complete at this time. A close observation and tests are continually being made with this apparatus, however. The results so far have failed to give any marked saving in the dilution test. In abrasive tests the filter seems to stop at the larger particles but the smaller dust and abrasive particles pass through the filter.

The committee feels that the two factors of most importance in producing dilution are the excessive use of choke and the unburned gas passing by the piston and rings to the crankcase at low engine temperature. Tests show certain factors which tend to

eliminate this diluent from the oil. Water temperature should be approximately 170 deg. F. Also crankcase temperature is a factor that is of equal importance.

What remedies are necessary? Thermostats and evaporative cooling systems designed to maintain reasonably high jacket water temperature are among the items that should not be overlooked if engine life is to be increased. This is also a subject to which automotive engineers should give considerable thought.

Improved carburation and distribution, filtration of oil and cleaning of air, the means for quick starting and thus eliminating excessive use of choke, use of automatic radiator shutters and the education of operators, are mentioned as possible remedies for excessive dilution.

The following data were taken from H. C. Dickerson of the research department of the S.A.E. on vaporizing end points of fuel of the past and present standards:

1922	427 end point
1923	435 end point
1924	437 end point
1925	437 end point

Air Cleaners

Air cleaners were given some thought by this committee. Crankcase breather action is the cause of much oil contamination; the extreme case being that of an engine with unbalanced reciprocating parts, in which the crankcase volume increases and decreases by the piston displacement during each revolution, as a result of which there is a constant inrush of air into and an outrush from the crankcase. When the unit is being driven on dry dirt roads this air will contain a considerable amount of dust.

Research on air cleaners has shown that the best way to retain dust carried by an air stream is to bring it in contact with oily surfaces, hence it is probable that of the dust entering the crank chamber with the air through the breather very little passes out the same way again. It is true that engines are provided with openings in the crankcase, but these serve only as vents to keep the pressure within the crankcase at atmospheric level. If no such vent were provided leakage past the pistons would raise the pressure more or less above atmospheric level and there would then be a tendency to force the lubricating oil through the bearings and through any poorly fitted parts of the joints between the crankcase sections and between the crankcase and the cylinder block. Therefore in an engine with inherently balanced reciprocating parts practically no dust enters the crankcase directly, and this should tend to preserve the lubricating qualities of the oil and to reduce the wear considerably.

Tests were made on No. 1 air cleaners and No. 2 on White and Mack equipment of 3½-ton capacity. The method and apparatus used in the test follows:

A course was laid out one-half mile in length from a point on Fifth Street to a point at the curb line of Fifth and Townsend. This street has bitumen pavement and is considerel level. In the following data the starting line will be designated as "A" and the other line one-half mile distant as "B." The method of measuring fuel consumption was with a dispensing burette connected to the carburetor, with a gravity head of 25 inches. The method of obtaining the CO_2 gas analysis was:

The analysis was taken after the water in the intake water manifold reached the temperature of 160 deg. F. and the r.p.m. of the motor set to a r.p.m. considered an economical efficient operating r.p.m. (This data was taken from manufacturers curves.) When the motor was adjusted to these specifications the CO_2 test was taken. The oil in each unit had been in operation for 300 miles and was sampled in the following manner:

The crankcase was drained and cleaned. The oil was then aerated and a 1,000 c.c. sample taken. The sample was then diluted in gasoline and filtered. The time factor did not allow a quality or quantity analysis so only the dilution test was made. The total weight of each unit loaded before the test averaged 19,000 lb. and the time over the one-half-mile course averaged 3 minutes per unit, or a speed of 10 miles per hour. Result of the test follows:

The White 3½-ton units were tested from A to B and from B to A with cleaners operating and removed. No carburetor adjustments were made and each unit was taken over the course twice to obtain averages.

TEST RESULTS

Fuel Consumption

Whites—	From A to B	From B to A	Per Cent CO_2 Test
With cleaner operating	550 c.c.	560 c.c.	7½
With cleaner removed	530 c.c.	550 c.c.	6
Macks—			
With cleaner operating	650 c.c.	700 c.c.	9½
With cleaner removed	550 c.c.	600 c.c.	6½

The No. 1 cleaner installed on the Whites is of the fan impeller type which relies on centrifugal force to get results but as the fan's velocity increases with the acceleration of the motor, this seems to have a damper effect on the air intake velocity and in no way filters the air that reaches the carburetor. The oil test on Whites showed a residuum of foreign matter in the oil and the dilution test gave a 12 per cent to 12½ per cent dilution.

The Mack units with the No. 2 cleaner restrict the air velocity to the carburetor and the retardation of this flow is governed by the amount of material collected on the filter felt. The felt filter in this case did collect a certain amount of material, but no test was made to determine the saturation point of this material. The oil in the crankcase was treated as specified and the amount of foreign matter and abrasives considered below the average for the mileage operated. The per cent of dilution was 12 per cent to 16 per cent. We might add that the damp atmosphere of the Bay region materially affects and causes additional restriction.

Company C is figuring on standardizing on the United Air Cleaner.

Company D is contemplating standardizing, the make of air cleaner not yet decided.

Company E is contemplating standardizing, the make of air cleaner not yet being decided.

Company H is not contemplating standardizing on air cleaners.

Company I is not contemplating standardizing on air cleaners.

Oil Cleaners

There are several different methods of maintaining the cleanliness of oil in automotive equipment. These fall into several different classes. The first class relies on the prevention of dust entry to the oil system; the second class relies on the removal of impurities by filtration and the third class relies on distillation of unburned gas residue and is usually used in conjunction with one of the other types of cleaners. In all forms of this equipment, the use of good oil is of paramount importance, as all that is true of good lubrication under ordinary circumstances is given added significance when an oil is subjected to odd usage.

Dust Entry Prevention Type—In this first type of cleaner, the dust is either filtered from the air entering the carburetor by means of a framed cloth sack soaked in kerosene, or else the dust is entirely removed by increasing its velocity over that of the air through a venturi-tube, or again it is cleaned centrifugally by means of a fan. These devices are very simple and generally filter all but about 1 per cent of dust from the air entering through the carburetor. They perform a real service in that they reduce the grinding action of such dirt by keeping the oil free from hard particles, but they do not prevent contamination of oil either from minute particles of metal from the motor itself or from the oil, carbon and water sludges which may form in the engine.

Filtration Type—The second class of equipment simply filters out impurities in the oil by means of a cloth or screen placed in the oiling system. This apparatus is very effective in keeping the oil clean and may be used in conjunction with an air strainer. But it does not remove any dilution. One of the most common of this type on the market today is the No. 1 and it has given excellent service as factory equipment on several cars.

Another similar method is used in the No. 2 device. This apparatus combines filtration with removal of the dilution by passing a stream of air through the oil. The air naturally carries with it a certain amount of the volatile constituents of the crankcase oil, and

thereby reduces dilution. This apparatus has not been widely used as yet, but offers some promise of success as there is no appreciable burning action on the oil, the only disadvantage being that in the case of low quality oils, the oxidation sludge may be formed which will clog the filter and, in time, the oil lines of the motor.

Distillation Type—In those classes of purifiers which depend upon a removal of the dilution, the No. 3 and its modifications are meeting with the largest use. In brief, this machine draws a small quantity of oil from a small orifice near the bottom of the cylinder bore. This oil is carried to the upper dilution chamber, where the heat of the exhaust gases is utilized to drive out unburned gasoline and water vapors and the remainder of the oil is returned to the crankcase for further use. It is customary to use this equipment in conjunction with air or oil strainers, since there is no provision made to take care of foreign matter.

Good Oil Is a Necessity

Any oil will deteriorate from use, and while the filtration systems in use have little if any detrimental effect on the oil in the motor, since they are merely mechanical separators of dirt, it is obvious that a poor quality of oil will break down much sooner than an oil of highest quality, thus defeating the very purpose of the oil cleaner, which is to prolong safe lubrication. This is also true in the other systems in which air or heat is used to vaporize unburned motor fuel, which will harm inferior oils if they are not carefully watched and the flow of oil to them regulated.

A number of automobile manufacturers are including these devices on their latest models, and they have given good service to date. It may be that a more complete system can be designed in the future which will expel exhaust gases without the slightest chance of harming the oil or else will entirely prevent dilution. Until this system is designed, it is necessary to use the highest grade oils in motors employing heat or air as rectifying agents. And even then, since a rectifier is only an aid to lubrication, safe lubrication can only be assured through the use of the highest grade oil.

Oil Filters

There was a test made by the Company A of the No. 2 device installed on a Dodge touring car and operated four months to determine the amount of foreign material collected by the filter and also the per cent of dilution. The total mileage for this unit was 6,000 miles. The filter was then disconnected and cleaned and the insoluble material weighed and found to weigh 158 grams; the oil tested and found to have a dilution of 8½ per cent.

The following test was made by an oil company of California under California conditions; tests being made by its laboratory. The analysis follows:

Item	Per Cent
Oil	32.8
Fuel	25.8
Water	40.0
Worn metal	1.0
Bearing metal	0.2
Dust	0.1
Carbon	0.8

The No. 3 system operates on a distillation principle. Excess oil is drawn off the cylinder walls by vacuum and is passed through an exhaust-heated rectifier in which the fuel particles are distilled off and returned to the intake manifold, while the purified oil is returned to the crankcase. The oil rectifier embodies a thermostatic temperature control which prevents overheating of the oil. As the distillation occurs under a partial vacuum, a temperature of 150 deg. F. has been found sufficient to distill off all but the heaviest fuel fractions. Through this method crankcase oil dilution is kept well below 10 per cent.

The oil rectifier proper is located close to the exhaust manifold, the upper part of the device being surrounded by a jacket through which part of the exhaust gases are by-passed. A hole is drilled through each cylinder wall just below the lowest piston ring when the piston is at the bottom of its stroke and a manifold connects all six cylinder openings with the oil rectifier. Another important feature of this equipment is that a small hole is drilled through the wall of the piston in the bottom ring groove and diametrically opposite the oil hole in the cylinder wall. This allows oil or vapor from the crankcase to enter the ring groove from the inside of the piston, relieving the vacuum and allowing the excess oil to be drawn off the cylinder walls through the oil manifold.

The No. 2 device is designed to remove foreign matter, including dirt, fuel and water from oil in the lubricating system of the engine. Oil, together with some air, is drawn from the bottom of the crankcase of the engine through copper tubing to an exhaust-heated reservoir and thence is delivered into the upper air or float chamber of the tank. When the level in this chamber reaches a certain point the flat mechanism opens a valve and spills the oil from the chamber to one below it in which the filter is located. After passing the filter, the oil returns to the crankcase of the engine by gravity.

The No. 1 device consists of a process of microscopic filtration (not screening), by which process dirt is removed from the oil as the car runs. If installed when the car engine is new, this device will, we feel, postpone to a distant day the necessity for motor overhaul and at the same time will save 60 per cent of the ordinary engine maintenance charges. It also saves in oil, but this is but a small item compared to the way it saves the working parts of the motor from the damage caused by abrasive dirt in the motor oil. It aids the motor to more power and greater smoothness by aiding the engine to always have proper lubrication.

Reclamation of Oil

Many kinds of apparatus are on the market today for the reclamation of oil.

A crankcase oil reclaiming outfit has been developed by a well known separator company. For all practical purposes, the oil coming from this apparatus is re-refined. The process is simple and the outfit foolproof, and is easily handled by the ordinary garage help.

We find that this oil purifier has been used for a number of years by a number of truck and taxi cab fleet operators to centrifuge solid impurities and water out of their crankcase oil, in which service they have proved their efficiency and economy. Now this crankcase oil purifier provides a simple and economical means of restoring oil to its proper viscosity as well as removing solids from it.

The complete equipment consists of a purifier motor equipped for centrifuging out of the oil such solid impurities and water as it may contain; a wash tank for chemical treatment and washing of the oil in order to remove colloidal carbon; an oil pump motor equipped; electric oil heaters for keeping the oil at proper temperature during the process of purification; an air blower and evaporating tower to restore the oil to its proper viscosity; a strainer; a sight flow glass; electric control board and all piping and valves.

To give a brief description: the wash tank is filled with dirty oil, which is raised to a temperature of 180 deg. F. by circulation through the heaters. There is mixed with the oil in the wash tank a milk alkali solution. This coagulates the colloidal carbon, which is ordinarily very difficult to remove, so that when the entire mix is passed through the centrifugal purifier, as the next step in the process, both the carbon and the solution itself are removed from the oil. A quantity of fresh, clean water is then mixed with the oil and a thorough washing is effected by another passage through the purified. At this point the oil is found to be free from solid matter and moisture and the next step is to restore its viscosity by passing it through the evaporating tower to drive off the light ends of unburned fuel with which it has become diluted. This tower is constructed so that the oil is circulated through it in the form of a fine spray, encountering a strong air current which effectively carries off the light volatile oils or dilutents. The resulting viscosity of the oil is entirely dependent on the length of time the circulation through the tower is carried on.

Company A made some experimental tests with this machine, using Zerolene oil type "F." Report is incomplete at present but will be completed at a later date.

For the S.A.E. recommended practice on crankcase lubricating oils, reference to S.A.E. Handbook, Vol. 1, p. D151, is suggested.

Automotive Records and Accounting Practice

By C. D. WEISS and J. S. MOULTON

This subcommittee of the Transportation Section, consisting of C. D. Weiss and J. S. Moulton, was detailed to obtain the practices of the various utility companies in California as related to the keeping of records and costs for automotive equipment. At this date replies have been received from practically all of the companies having representation on the Transportation Section.

Your committee is taking upon itself the prerogative of drawing certain very general conclusions from these letters in place of outlining in extreme detail the methods employed by the various companies and in making recommendations as to those things which, in their opinion, would lead toward the adoption of a sufficiently unified method of record keeping to enable comparisons to be made between the several companies.

With one exception the companies all keep segregated records of operating expense for their different individual pieces of automotive equipment. The general segregation of these expenses into gas, oil, tires, repairs and general overhead is the same, although the detail of what enters into the various subdivisions varies somewhat with the companies.

The practice of charging for the use of the equipment on a mileage basis or on an hourly basis seems about equally divided. The arguments in favor of one or the other system seem to be based largely upon the use made of the equipment and no general rule should be urged for all companies. This feature is one of expediency to obtain the most correct charge for the use of the equipment and is somewhat outside of the realm of this report, which is concerned more particularly with keeping the operating costs of the equipment regardless of how they may be later cleared.

Recommend Standard Practice

Your committee recommends to the Transportation Section that the first move which should be made toward obtaining the adoption of records by the various companies which will be comparable is to have the representative of each company on the Transportation Section take back to his company a story of the purpose which it is hoped will be accomplished by the unifrmity of accounting records and practices. It is more reasonable to expect comparable costs with companies all operating in California than it is to expect uniform costs from companies operating at greatly separated points in the United States, even though these companies may be under the direction of the same parent company. This fact should assist in persuading those companies which are directed by an outside agency that slight changes in their accounting procedure would enable both the usual reports to be made and reports for comparison purposes with other California companies as well.

If the various companies profess a considerable interest in the proposed general plan for unification of records, then a committee of the Transportation Section can, through a series of conferences, work out a plan which could be fitted into the various companies with the minimum amount of change. It would be extremely wasteful of time and unproductive of result to attempt to lay out such a plan if the companies for which it is done are to be entirely unresponsive to the results.

There were several pertinent suggestions in the replies received from the various companies which will undoubtedly be of interest to the committee.

Separates Construction and Operating

Company B states that in keeping group operating and depreciation costs "we also distinguish between cars used in construction work and those used in operating. This we find has been a very important item, as cars used in construction work depreciate approximately 50 per cent sooner than those in operating work, and as construction work is mostly chargeable to capital accounts, it is very essential these costs should be reflected in our capital accounts rather than be absorbed in a group average of operating department cars."

Company E charges the difference between the estimated salvage value of a piece of equipment and the realized salvage value to the cost of the new unit. Several of the other companies keep a depreciation adjustment account and do not burden or relieve an individual new piece of equipment with the inaccuracy in estimating the salvage value of the old equipment. The method of using the general depreciation adjustment account appears to this committee to be preferable.

Charging Garage Building Rental

The detail of the garage overhead account varies more than do the other accounts and seems most productive of error if costs including this account are compared. Among other items entering into it is that of rent on garage buildings. Two examples will be given to show how this item alone can considerably affect the result.

Assume two companies having garages of equal floor space and efficiency and both costing the same amount to maintain. One of these garages is rented from an outside owner by the company, while the other is owned by the company itself. In one case the rental for this building would be included as a garage expense; in the other case no similar charge would appear as the interest and depreciation on the investment; the maintenance, taxes, etc., would not be chargeable to this account. Cost comparisons between the two companies under this condition as regards the garage expense would be faulty.

As the second example, two companies rent garage buildings of equal car capacity; one of these buildings being located in a small town where land rent and taxes are low; the other being located in a large city where land rent and taxes are high. Such conditions are outside of the control of the transportation department, and its general garage expense, while reflecting the difference in these items, would not be a criterion of the efficiency of the transportation departments of the two companies.

In conclusion it is the recommendation of your committee that before further detail work be undertaken toward the setting up of a method of producing uniform account and record keeping practices as relating to automotive equipment in the various Pacific Coast companies, that expressions be obtained from these companies as to their attitude toward accepting and putting into force such a plan.

Electric Trucks—Their Selection and Application

By W. E. GALLEMORE and D. C. BERTRAND

Economy and satisfactory operation of electric trucks, as well as of other types of transportation equipment, depend upon a thorough analysis of specific requirements.

In considering the type of equipment to be selected the character of the work to be performed is the principal factor. It is just as wrong to place a gasoline driven vehicle on short-haul, frequent-stop work as it is to attempt to use an electric truck for long distance hauling. While it is true that in the gasoline truck we have a unit which is far more flexible, it is also unquestionably true that the electric truck, in its proper field, possesses many advantageous features.

While the greatest efficiency of the electric truck is obtained in delivery and pick-up service and in congested traffic areas, actual comparative tests conclusively demonstrate, in certain instances, a greater efficiency for the electric truck in central station service involving relatively few stops, providing that service is within the cruising radius of the electric. This cruising radius depends upon—

(1) Load Conditions. Whether the load remains constant throughout the period of operation; whether it diminishes and at

what rate, as well as possible over-loading are factors to be considered.

(2) Topography of Route: General road conditions and gradients are of vital importance. They pertain directly to the application of electric trucks and affect the radius of operation, although we have many successful installations where hills of an extreme nature are encountered.

(3) Stops: In practically every class of hauling which necessitates frequent starts and stops, the speedy acceleration and ease of operation of the electric truck render it the most efficient and economical unit of transportation.

(4) Time Element: The period of time in which it is necessary to handle the given work is of vital importance and the electric truck stands out favorably in congested traffic areas in cities as well as for reasonable suburban service, owing to its constant speed.

Selection of Electric Truck Transportation Equipment

We believe that the most satisfactory installations of electric trucks are those in which the work to be done has been surveyed by the electric truck itself, which makes possible its direct application to that particular work. This may be done in the following manner:

(1) **Chassis:** This should be considered from the standpoint of load capacity as well as design.

(2) **Motor:** The rated voltage and amperage of motors, in connection with gear ratios, should be considered as to their relation to the conditions under which truck is to operate.

(3) **Controllers and Other Auxiliary Equipment:** Owing to the nature of the draw on the source of power, controllers are designed very liberally and have met general applications in this field with excellent results where a reasonable degree of maintenance is given.

(4) **Storage Batteries:** The voltage of the battery should be figured in proportion with the motor of the vehicle being driven, as well as charging conditions which may exist. Reliability and economical life, as well as suitable operating characteristics, are the desired features from the storage battery end. Likewise important is its efficiency in delivering the energy rquired for th satisfactory operation of the vehicle.

(5) **Charging Equipment:** Charging equipment should be selected to meet the requirements of the batteries. It is not necessary to install elaborate equipment, which in some cases has been done, but simplicity of arrangement is desirable. Manual or automatically controlled apparatus may be selected to meet conditions.

We believe that electric transportation has been developed to the point at which it is well deserving of consideration for application to any work within its field.

Repair Shop Equipment and Methods

By V. W. DENNIS and D. P. MASON

As the various company shops covered in this paper are operating under such varied conditions it was felt that the method used was of more importance at this time than the equipment used, so methods only will be considered at this time.

From the questionnaires made out by the various operators it appears that their operating conditions and number of vehicles operated call for an entirely different shop and maintenance set up.

Two companies only consider it necessary to overhaul trucks annually, the others overhauling whenever it is considered necessary from a mileage basis or from inspections or reports from their shop forces. This appears to be at intervals of from 1½ to 4 years. Dodge and Ford trucks are considered on the same basis as the larger trucks. Dodge passenger cars are overhauled whenever their condition warrants it, although one company overhauls or trades them in when they have gone 40,000 to 50,000 miles.

Ford passenger cars when overhauled are handled on a mileage or condition basis, although some of the companies using a large number of Fords are only doing light overhauling and when the car is in need of a major overhaul, it is turned in on new equipment.

Overhaul Methods

Eight companies consider regrinding the proper way to refinish cylinder blocks, two companies rebore and hone. The variations in cylinder wear before refinishing are from 0.003 to 0.015 in diameter and approximately the same for taper. This variation, of course, is regulated by operating conditions to a great extent, but it is a subject that should call for some discussion, as it has a large bearing on economical operating. Standard valves and piston rings furnished by the car manufacturers are universally used except that oil scraper rings are considered necessary.

Where special jobs call for other than the standard valves the Jadson or Thompson Silachrome valve appears to be the most popular. The use of mechanical devices for bearing work does not appear practical for small shops, but in shops handling a large volume of work they are considered a necessity. The reamer type for main bearings are the most used. This type was one of the first introduced which may be the reason for its popularity. Most of the connecting rod bearings are scraped by hand, but where mechanical devices are used they are usually of the fly cutter type.

The time used for running in motors after overhauling varies from 2 hours to 8 hours. Six companies use the unit system of motor repairs, principally on Fords. This is a system requiring a large fleet to operate successfully.

Pits of the closed end type are used by all companies.

Overhead cranes in the larger shops and portable cranes in the smaller ones are used in preference to the elevated runways.

Two companies use portable benches and five companies use special benches for their mechanics' use.

Hand tools are furnished by only one concern. Steam cleaning plants are considered a necessity in the larger garages.

Painting of Equipment

Vehicles are usually painted whenever needed, although two companies paint at regular intervals. Six companies use a quick drying paint or enamel. It appears that approximately 24 hours is considered as quick drying. Seven companies apply paint by the air spray system which is usually of the stationary type, and in each case is applied by regular painters.

Inspectors are used by seven companies and it is the general rule that the inspector takes care of adjustments and light or emergency repair work, although in two companies he does only the regular inspection work. These inspections are made as required, weekly, monthly or annually, varying according to the class of work taken care of. Vehicles overhauled are usually inspected by the garage foreman, except in one or two companies. Only three companies use a regular inspection form.

Trouble shooting and motor work is done by specialists in six companies. These companies as a rule employ apprentices rather than helpers or handy men.

Garage and shop men are paid usually on a day or monthly basis.

It was considered advisable to use the operating procedure of one shop as an example. This was furnished by Mr. Wainscoat of the San Joaquin Light & Power Corporation.

Cylinder Refinishing

There are several well known processes for cylinder refinishing. In all probaility the most commonly used are regrinding, honing and lapping. However, it is our experience that the latter two are not necessary except in rare cases where a temporary or partial correction is desired, but in point of economy, accurate

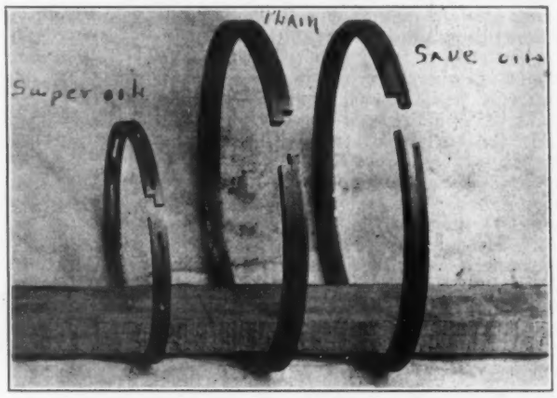


Fig. 1. Types of rings used. Center ring is plain ring used for first two grooves at the top of pistons. Left ring is of oil ring type, as is the ring on the right with a beveled groove running around it.

work and general efficiency, we have found regrinding, if properly done, to be the only satisfactory means of cylinder renewing.

It has been our experience that with the use of a Heald grinder, such as we use, a proper placing of the block in order to secure a minimum removal of metal is quite necessary. At no time should a cut of sufficient depth be taken as to cause a strain upon the arbor or generate heat to any degree within the cylinder wall being ground. Either of these, we have found, will cause an untrue wall after the cylinder has been allowed to cool. The last cut should be made very light and without crowding. If care is used it will be found that a very smooth, satisfactory

Fig. 2. Rings are fitted so that they will close with a pressure of seven pounds.

job can be had with the removal of a minimum amount of metal. An accuracy of 0.00025 variation is more than sufficient for perfect performance. At the time cylinder blocks are refinished, the valve seats should also be re-established for the purpose of securing a narrow seat, one without pockets or ridges about the edge of the valve proper.

We now come to the question of proper pistons and the fitting of them to the block. Through much experimenting we have developed the use of medium weight gray iron pistons for replacement purposes in all regrind jobs. These pistons, when properly centered and turned, are given a clearance of 0.00075 to the inch of piston diameter.

In most cases indeed these gray iron pistons will exceed in weight but a few ounces the present day popular, light weight, alloy piston, although in performance and greater over-all efficiency they will outwear two to three sets of alloy pistons, both as to measurement for wear upon them and upon the cylinder block. This may seem strange but careful measurement and inspection will soon convince one. Alloy pistons although light and apparently soft, are surprising in that aside from the fact that they requite a greater allowance for expansion, they wlil wear the cylinder walls as much as 0.008 or 0.009 in the low mileage of from 10,000 to 12,000 miles. This is due to the fact that alloy pistons when subject to heat and oil develop a thin, hard, skin-like surface which in most cases is sufficiently hard to turn the point of a sharp lathe tool.

Rings—Types Used and Refitting Methods

We are using a plain, turned, step-cut ring of low cost. (See Fig. 1.) These rings are fitted with practically no gap allowance for expansion, due to the fact that they are turned in what is known as semi-rough state, which gives them a uniform, quick seating feature. However, care should be used to see that each ring fits easily and freely in its ring groove. These rings must not have a compression tension, to close the gap, or greater than 7 lb. (see Fig. 2), as

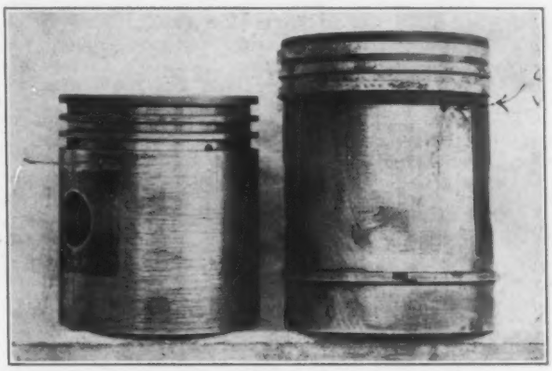


Fig. 3. Holes drilled in the pistons at the lower ring groove to drain oil. At left the present practice is shown. At right the old method of drilling now abandoned.

our experience has shown that a ring of greater tension will not only increase friction and wall wear but also will not properly fit itself, due to the peculiar characteristics of ring stock when subjected to heat and pressure.

This type of ring we place in the first two grooves upon the top of the piston. The third groove is reserved for an oil ring. We drill five 3/32-in. holes at the inner lower edge of the latter ring groove to serve as a drain. (See Fig. 3.) The oil ring is nothing more than a ring of the same tension, quality and design as the two above, with the exception that a V-shaped groove is cut in its outer lower edge or face to a depth of approximately 1/16 in., and the top edge is bevelled to the same degree. (See Fig. 1.)

We have also used other oil rings with practically as good results. It will be noted that both piston and ring are turned instead of ground, the reason for this being that a turned piston or ring retains an ability to carry a sufficient amount of lubricating oil to protect it from freezing or scoring while in the process of running in.

The wrist pin bosses are reamed with spiral reamers, with just sufficient clearance to permit the connecting rod to fall from a horizontal position of its own free weight. The rod and piston are now ready for a check as to alignment, for which purpose we use an Erickson aligning jig. Care must be used in this operation as a slightly twisted or cocked wrist pin or rod will cause excessive oil pumping as well as cylinder and bearing wear, and in many instances, high metallic knocks in the motor.

Cylinder blocks fitted in this manner have given us an average life greater than any so far secured in new equipment and with a minimum amount of trouble.

It might be well to suggest at this time a careful insepction of all water circulating ways in or about the valve seats and cylinder walls. We have found in a few special cases that cracking of the cylinder walls or valve seats is likely to occur if for any reason these passages are in any way clogged with foreign matter. Particular attention along this line is necessary in a few motors. The water passages in certain types of motors near the valve seat are very small in size and subject to frequent clogging. The cylinder block is now ready for installation upon the crankcase.

Reassembly Practice

It is advisable, we find, to tighten the studs which hold the block to the case which are located between number 2 and 3 cylinders, and then working from this point toward each end of the block. This will lessen any chance of oil leakage or springing of the case. The same procedure is also advisable when installing the cylinder head.

We are now ready to insert the pistons and connecting rods within the cylinder, and connect up the rod bearings to the crankshaft. We find through experience that in connecting the rod bearings to the shaft that a clearance of from 0.001 to 0.002 is to be preferred over a snug or tight fit. We also find that where the shaft is out-of-round by not to exceed 0.0015 or 0.002 in., no harm will result to speak of. However, any greater amount of out-of-round will cause a shortening of bearing life. We find in actual practice that connecting rods and main bearings composed of pure block tin to the extent of 80 per

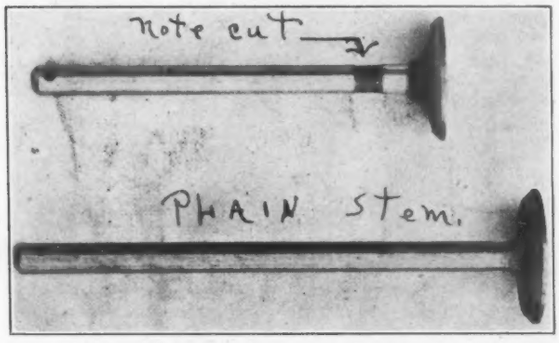


Fig. 4. Valve stem recessed to eliminate sticking, as compared to the ordinary valve in the lower example.

cent copper and antimony comprising the balance, give us the least trouble and the greatest amount of mileage. Bearings of the above type may be purchased from almost any of the reliable parts companies, and also seem to be in use on many of the more recent motor cars.

Consider Valves

We will now consider valves. At present there is much discussion on this subject. However, we find that although valves may be obtained under various trade names, nevertheless they are made up mainly of the following metals: tungsten, silichrome or cast iron as a head metal, with various processes being used for the heat treating of them. We have tried valves in all of the metals mentioned and have practically adopted as standard a tungsten valve.

This valve, although not as high in heat resistance qualities, nevertheless is sufficiently high to be above normal operating temperatures. Perfect satisfaction should result in every instance where they are used with the possible exception of those few cases where other motor action, such as defective gasoline, poor water circulation, or improper tappet setting, intereferes. In those few instances, sticking valves or burned seats may result.

In practice, to eliminate burning through tappets being adjusted too high, we have found that a clearance varying from 0.004 to 0.010 is used, due to the grades of iron used by different manufacturers in cylinder block casting and their processes of treating. Some blocks have a growth or expansion under heat in the same ratio as valves, in which case the adjustments may be as low as 0.004 for clearance. However, in most cases valve stem expansion may be as much as two or three times the growth or expansion of the block. This difference must be measured and compensated for in the valve tappet adjustment. We find that if this practice is carefully followed no trouble will result.

In most cases where trouble is experienced by carbonizing or gumming on the stems below the head, due to effective gasoline, relief may be had by turning the valve stem or recessing the valve head a distance of 1/16 in. below that point at which the top edge of the valve guide rubs, and to a depth of 1/32 in. (See Fig. 4.) This gives the guide a shearing effect upon the valve stem at the point of trouble. It also prevents carbon and gum from piling up sufficiently to cause a shoulder which might cause the valve to hang or hold open.

Valve grinding in present day motors is largely required because of the condensation in the valve cover chambers, due to improper lubrication and venting, or poor quality of gasoline. Cases of valve grinding through normal wear are rare. In fact it has been our experience that a motor will operate with present day valves under normal conditions over a period of from 10,000 to 12,000 miles without loss of efficiency. In some rare instances we have found valves defective or seating improperly due to unusually soft valve seats, which permit the valve to heat itself down to a point where the stem rides the tappet. In this case, unless properly cared for, a burnt valve will result.

What Causes Valve Trouble

Condensation we have found, causes an accumulation of moisture about the valve stems, which in turn sets up a corrosive action causing the stems to stick in the guides. We have overcome this by drilling from the valve chamber into the crankcase proper, thereby permitting added lubrication to the springs and stems. This also provides a means of air circulation having a tendency to check the condensation.

The question of poor quality gasoline is one which at one time gave us considerable valve trouble. Gasoline is made in two classes or specifications. One is known as aviation gasoline and the other motor gasoline. These classes are established by the U.S. Government under its specifications. Motor gasoline, to be high grade, refined and free from water and all impurities, must have a vapor tension not greater than 10 lb. per sq.in. at 100 deg. F.

These requirements are designed to prevent the addition of too great a percentage of casing head gas and are usually covered by the initial boiling point, rather than an estimation of vapor tension. We would suggest an intial boiling point not less than 108 to 110 deg. F., using 100 c.c. as a sample. The boiling point must not be higher than 140 deg. F.; 20 per cent must distil below 221 deg. F.; 45 per cent must distil below 275 deg. F.; 90 per cent of the sample must distil below 360 deg. F., and the end-point should not be higher than 437 deg. F. Slight color is not to be regarded as having much significance.

However, the doctor test of gasoline should be negative and in the corrosion test, gasoline should

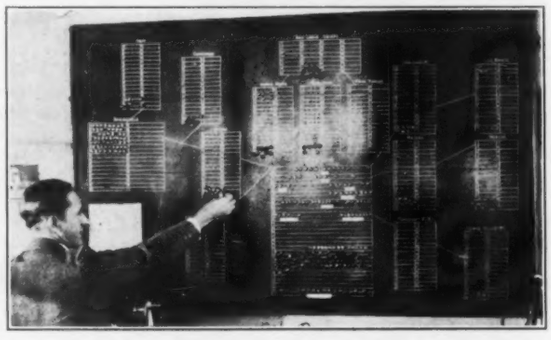


Fig. 5. Oil record chart maintained at the main garage. Each car is given a numbered button, which is stuck into the board in a space allotted to the division in which it is operating at a point opposite a date at which it is to be relubricated.

show no grey or black corrosion and no weighable amount of gum. The maximum allowable residue in the corrosion test is 11 milligrams for 100 c.c. of gasoline. Occasionally gasoline contains heavier oils which do not volatilize at the temperature used in this test. Such oils will run the residue much higher than the limit allowed.

We have given the above specifications in order to make clear those parts which cause serious valve

trouble. Those parts may be found in the amount of corrosive and residue contained as well as in the doctor test. Unless these are as specified herein, a heavy gum coating will develop on the valve stem due to the heat action upon the gases. This gum, we have found, will cause valve stems to hang open within as little as 500 miles running and upon cleaning and regrinding to repeat hanging up within the same mileage. Therefore, we analyze our gasoline periodically. Since the adoption of this plan we have experienced a minimum of valve trouble.

Shop Equipment

From time to time we have tested out and adopted various kinds of shop equipment. And we have rejected many others. We have so arranged the garage, that each mechanic has his individual bench and floor space, with complete electrical equipment for drop lights, electric drills, etc. Pits are provided at various points in the garage in order that repairs may be made conveniently beneath the car or truck.

The garage is heated throughout the winter months by means of oil burning furnaces, in which old cylinder oil and distillate are used on a 50-50 basis. The average temperature maintained is from 60 to 65 degrees, this having been determined as the most satisfactory working temperature. A large wash room is provided with hot and cold water wash trays and individual lockers. In the summer months complete ventilation is made by means of window ventilators, overhead skylights and large doors.

A 20-ton capacity, screw-type press is conveniently located in the garage, as well as a direct-drive, double-arbor, motor-driven emery wheel. Adjoining and in conjunction with the garage, is maintained a complete machine and blacksmith shop in which machinery for all classes of wood working is to be found, also a complete equipment for forging and blacksmithing. We also have acetylene and electric welding equipment. In the machine shop proper are to be found a Heald grinder of the latest design, a large Universal grinder, four different types and styles of lathes, a large and small drill press, a tool grinder, a miller and shaping machine and also a power hack saw. This machinery is all electrically driven and operated by competent machinists.

These machines, as well as all other garage apparatus, are completely equipped with the most modern safety devices. We have a safety committee composed of members chosen fro meach department. It has regular monthly meetings and discusses any new hazards which may develop, as well as motor car accidents and personal injuries. Its report is then filed with the central committee for further action.

Fire extinguishers and fire hose are installed in and about the garage and shop at convenient points. Large storage sheds are maintained for the storage of all motor cars and trucks. A large service station is operated at one end of the storage sheds. Service may be had at this station at any time of the day or night. Each car or truck placed in storage at night is carefully serviced by the station operator with gas, oil and water. The tires are tested and properly inflated.

Should the service man find any trouble in a car or truck he repairs it if it is of a minor nature. If he finds serious trouble he makes a duplicate report of it, one copy being placed on the foreman's desk and the duplicate copy being attached to the steering wheel of the car involved, with instructions to the driver to report to the foreman upon his arrival. Should the case require immediate attention, the garage foreman is notified by telephone and a mechanic dispatched to correct the trouble.

At all points in the garage shops and storage sheds compressed air is piped and hoses are attached for convenience. A steam cleaning and paint removing rack is also maintained. This is in operation during the evening and night hours in order that equipment requiring cleaning may be thoroughly washed up for the next day's service. At this place cars are also prepared for painting. A trim shop with complete equipment and stock is maintained, likewise a complete paint and varnish department.

Inspection Methods

Motor car inspection must be consistently followed up by prompt repairing. The real sources of trouble must be discovered if maximum efficiency at a minimum cost is to be obtained. We have found in practice that the most satisfactory method of inspecting equipment, especially in the outlying districts, is to have a qualified mechanic to make all minor repairs, such as valve grinding, adjusting bearings, and replacing minor parts, at that point on the system where the car or truck is in service. This means both a saving in time and money. These mechanics report all trouble direct, by private telephone, to the garage foreman who in turn issues instructions for the type and kind of repairs which shall be made.

At present we are using two such inspectors, one in the northern and one in the southern division. These inspectors are capable of calling upon each district at least once every 15 days, which we find sufficiently soon to take care of all pressing needs. These inspectors also report all cases in which equipment is being abused, such as fast driving, overloading or otherwise. Should trouble occur requiring immediate attention at some point at which an inspector is not obtainable, a mechanic is then dispatched from the central garage to take care of that particular trouble. These district inspectors are from time to time called to the central garage. At such times the foreman checks their previous reports and instructs them in proper methods of repair and servicing, as well as talking over with them any new developments in the motor industry.

We have had this method of inspection for approximately two years and have gradually improved it to raise its efficiency to the highest degree.

Methods of inspection at the central garage are somewhat different from those of the traveling inspector or mechanic, in that the garage foreman personally meets every driver of company equipment and discusses with him in detail the cause of his trouble. The foreman then issues what is known as a shop order upon which may be found a list of items which will practically cover the complete operations necessary for the complete overhauling of the car or truck. This shop order is so arranged that each repair made by the mechanic may be checked on the margin. Upon completion of the job the mechanic signs his name at the bottom of the order and returns it to the foreman with notations of any additional work he may have found necessary.

These forms are then filed for future reference, the orginal copies having gone to the main office in company with the daily time card, in order that a complete check of all work can be had. A space under "remarks" is provided at the bottom of these work orders in order that the foreman may issue special instructions to the mechanic when needed.

The foreman now carefully checks the car as to workmanship, general condition and operation in order that the smallest detail may not be overlooked, after which the car is turned over to the car dispatcher whose duty it is to return the car to its point of service and make the necessary records. At all times when repairs are being made, the foreman follows the work as done by the mchanic, instructing him as to the proper or best methods to use as well as to the type and kind of repair that should be made. The foreman must also check the car while it is in the shop as to its requirements in top and curtain repairs and note the condition of the paint.

Top and curtain repairs are made in our own trim shop while the car is in the repair shop proper. In this way there is no delay and a complete job is assured. Should the car have made so much mileage or be in such a condition that repairs seem hardly worth while, the foreman then looks up its record in a record book, compiled by the accounting department, which gives the cost of maintenance, and all other cost details on each car in the system. Should this cost be great enough to prohibit further expenditures other than of a minor nature upon the car, the foreman then consults the transportation superintendent. He reviews the matter and makes the necessary arrangements for the sale or disposal of the car, in trade or otherwise, for new equipment.

Trouble-Shooting

Trouble-shooting to us means determining the cause of faults and what the faults may be. This in the districts falls upon the traveling inspector in co-operation with the foreman by telephone. The inspector gives the foreman a complete statement of appearances and conditions of the particular car in trouble. The foreman then seeks to determine by analysis or a check of past trouble, the fault which presumably causes the trouble being experienced in that particular car. Should the fault be one of careless lubrication, neglect or improper care, he then reports the case to the transportation superintendent who in turn takes it up with the district manager, the object being to prevent such occurrences in the future. If the trouble experienced is of a major nature, and is due to improper care, a punishment is decided upon for the person driving the vehicle.

In cases of trouble which are brought to the central garage, the foreman arrives at the cause of trouble by direct conversation with the driver and then gives proper instructions to the mechanic for its correction. The above methods have been found very practical and agreeable to all parties and have enabled us to make a great saving in equipment, time and money.

The mechanical devices for trouble-shooting which we are using consist of detectimeters for coil and condenser trouble, Portastats for resistance tests on batteries, wiring, etc., and compression meters for ring and valve troubles.

Painting and Paint Shop Equipment

A painting department for a public service corporation garage is very necessary if appearance of company equipment is to be maintained at that high standard demanded by the public. Therefore, we have done much experimenting in order to determine which are then best of the various paints, enamels and varnishes available, and what are the best methods of application, in order to determine which pay the largest dividends in service.

We have found that Fords require an altogether different treatment from other makes of cars. We first tried repainting Ford cars with one and two spray coats of atuo enamel. But after these cars had been in service from two weeks to two months, checking and fading would be evident with the result that the car looked practically as bad as ever. We then tried the use of one spray coat and one coat of varnish with the same result. We found this checking and fading was due to the fact that the regular standard factory paint job did not have a sufficient base.

Therefore, we decided to experiment in paint removing. This we did by trying out various solutions, under different condition, on the old paint. These solutions consisted mainly of caustics. After much experimenting along this line, we found that a solution composed of 6 lb. of Babbitts lye, 2 qt. of ammonia, ½ lb. of corn starch, 5 lb. of commercial wyandott, mixed with 12 gal. of water and heated to a temperature of 210 deg. F. and applied hot to the paint by means of a gravity feed and a hose, gave quite satisfactory results when allowed to stand from 10 to 15 minutes before applying the steam, as used in car washing. This would cause the paint and defective enamel to slide entirely off the body, leaving a nice, clean surface. We then placed the car in the paint shop where it was given, by means of the paint spray, two coats of quick drying auto enamel.

This method of procedure made it possible to have the car again in service within three or four days, and cars painted in this manner have been in service from eight to ten months and still show no signs of fading or deterioration.

Larger cars have been painted with standard coach paints, varnishes or are lacquered according to the class of work for which they are to be used. Lacquer as applied with a spray, although at a slightly higher cost, has given us considerably more service and appears to be far more economical in the long run. This is especially true in view of the fact that a complete repaint job is not necessary at the time the removal of paint is desired, for a rub down, with one application of lacquer again places the care in service for as long a time as the original complete lacquer job.

Painting in this shop is not limited to motor cars alone. All trucks are painted here also. In painting trucks we have adopted a standard truck color of what might be called a dark brown. This color apparently maintains its appearance over a greater period of time, under all conditions, without renewal. Our method of application consists of first giving the truck a primer coat of lead and oil, after which it is rubbed down roughly and two coats of flat color applied by means of an air brush. After this it is given a coat of varnish. At the same time in which our cars or trucks are repainted, we also redress the tops and side curtains if necessary. By following this method we have been able to secure twice the life from the average top at but small cost.

However, it is well to consider that not all painting methods or kinds of paint will work equally well in all parts of the country, owing to differences in climatic conditions. There is much room left for experimenting along these lines, therefore.

Transportation Education

In the following series of papers the authors have endeavored to advance some measures of value toward more efficient handling of transportation equipment.

Educational Methods

Before attempting to train shop men, the machine shop arrangement, tool equipment, etc., should always be carefully scrutinized, checked and care taken to see that it is in the best possible condition to give the best results. Shop men should be given every opportunity to develop and advance themselves in their work. Men who cannot do this must be ultimately replaced with men who can. A shop organization should always be well balanced as between very expert high-priced mechanics, ordinary mechanics and apprentices of varying degrees of ability. By doing this we are assured over a period of years of having at all times a competent force.

Chauffeurs and truck drivers must be fit physically and steady and alert mentally. They must always be courteous, efficient and at the same time bear before them the mottoes "Safety First" and "The load must go through."

Safety Training

In education for the prevention of accidents, the first step is a campaign in first aid education, the second step is the institution of a safety first campaign and the third elimination of unsafe conditions. At the start of a safety first campaign one of the hardest things to do is to train men to protect themselves from the results of their own carelessness. At times drastic measures are necessary in order to attain this end. A first aid campaign and a safety first campaign carried through and backed by the management will work wonders in reducing accidents, promoting good feeling amongst the employees and preventing in many cases what would otherwise be human wreckage as the results of industrial accidents.

Training of Shopmen

By W. H. FAIRBANKS and D. A. RUNYARD

Before the training of shopmen is considered the machine shop should be carefully observed. A light, well ventilated, orderly and clean shop is necessary in order to turn out accurate and fast work. Shop equipment should be conveniently located so as to save time for the workmen. Constructive suggestions from the mechanics should be given attention and changes made where they will prove of mutual benefit. Employees will more readily co-operate with the management where they are provided with satisfactory working conditions.

The shop tools must be kept in repair and in place. It is advantageous to select some member of the shop organization whose duty it is to see that this equipment is returned when borrowed and who will take care of any equipment that needs repair. The foreman may interchange the members of the organization

to good advantage and give them all a chance to be custodian of the equipment. This procedure gives everyone an opportunity to see the importance of returning borrowed equipment. It is impractical for the company to furnish hand tools for the employees. Care should be exercised on the part of the foreman to see that each employee supplies himself with the necessary tools which will enable him to carry out his work.

It should be made clear to all new employees that they must co-operate with their fellow workers as well as with the management. If harmony does not exist in the organization then the brakes are applied to the wheels of progress. Employees who are willing to co-operate are ready to fit into any training or betterment program that the management may have in mind. Employees who are willing to do whatever is necessary generally find plenty to do between jobs and in the end they are benefiting themselves. It is up to the foreman to find the willing spirit in his man if it is to be found. But when a willing attitude is lacking there is no denying that the man is not fitted for that particular class of work.

Owing to the class of work a mechanic has to perform he should not be tempermental. Unfortunately he frequently is. The everyday discouragements in a machine shop, when parts do not fit and things are generally wrong, should not daunt a mechanic's spirit or temper. He must be courageous. He must not easily be discouraged. In order to turn out the right class of work he must be resourceful, exact, and energetic. The foreman having the foregoing ideals in mind will do what he can to see that the members of the shop organization are kept in a good frame of mind, and that no unnecessaray irritations are inflicted. Rules and regulations should be minimized. Rules pertaining to the safety of workmen should comprise the bulk of the shop regulations.

The Misfits

A mechanic who cannot assume responsibilities around a machine shop is a misfit. If he has not enough confidence in his work to be responsible for its exactness and completeness, then he is doing work which is far over his head. It would be the proper procedure to send such a man down the ranks and let him do such work as he is fitted to do until he realizes that he must assume responsibilities in order to raise his position. A man in this class may be a hard worker at routine tasks but lacking in confidence in himself. A talk with such a man, showing him his weakness, would not be amiss. He may appreciate the interest taken in him and strive to overcome his fault. Periodical interviews and assignments of responsibilities should be given such an employee. If the habit of shifting responsibilities prevails in the shop, then a service card which identifies the work done should be initiated by each mechanic. This will permanently do away with the shifting of responsibility and raise the standard of the work.

Dependable employees are very valuable assets to any organization. We are striving to create more dependable employees so that the general efficiency can reach a higher standard. Employees that one can trust to turn out perfect work, work where nothing is left undone, are not to be found wanting jobs. It is our problem, therefore, to train the employees if we expect a high standard of efficiency. Advancement awaits the employee who makes the best of his opportunities, and prepares himself for a better job. Praises may remain unsung for the good work a man performs but no one can take from him any credit that rightfully belongs to him.

An Individual Problem

Little can be said regarding any set standard for the training of shop men. There are many ways to raise the standard of an organization. It remains an individual problem owing to the diversified conditions existing in various organizations. What may be needed in one case might be superfluous in another. In this article I have attempted to bring together facts generally known to be essential to good organization.

Men selected for work in a machine shop, skilled or unskilled mechanics, should be clear thinking, broad-minded, and should possess both vision and the other qualifications as previously outlined. In building up a permanent force, care should always be exercised to keep it a balanced force; that is to say, to build up your force so that the apprentice of today will be the skilled man in the following years. Training is now simplified because we have selected the best of material with which to work.

Weekly Meetings

Weekly meetings held in the machine shop for the purpose of promoting efficiency are sometimes beneficial. These meetings should include all shop employees. New methods, instruction and many other subjects can be brought to everyone's attention at such a time. Work that has been completed and not done correctly can be brought forth so that a similar mistake will not be repeated and more care will be given to all future work. Constructive suggestions should be asked for from each member present and anything that anyone is in doubt about or not satisfied with, can be cleared up and not left in his mind to breed discontent.

Criticisms should be made to employees by the foreman in a private discussion and not taken up at the general meeting, except in a general way, merely calling to everyone's attention the fact that certain work was not perfect. Of course he must not identify the work with any particular member of the group.

Special work can be assigned and rotated at intervals among members of the organization. Special work may consist of checking motors, steering apparatus, brakes, etc. These assignments in connection with the regular work tend to make specialists and give everyone a complete knowledge of the various parts of an automobile. The added responsibility is beneficial, and when the assignments have been rotated and the cycle completed, the foreman will be able to select specialty men. Those not performing their assignments correctly will stay on the same plane until they raise their standards. Those who cannot raise their standards will eventually be replaced.

The assignment of other special work of a permanent nature in connection with the regular mechanical work can be made. In this class come tire repairing, battery work, welding, lathe work, tool and material custodianship. Men doing such work are, in the final analysis, specialists.

A school of instruction on mechanical subjects may prove helpful to mechanic helpers and others desiring knowledge to enable them to advance. If a night shift is not run, these schools can best be conducted evenings in the machine shop, where equipment is always available.

Many plans for training might be suggested here, yet the proof of any plan is the results which it will create. The management must set a high standard to work to and then assist the employees in every possible way to attain that standard.

Training and Selection of Drivers

By W. H. FAIRBANKS and D. A. RUNYARD

The question of training and selecting drivers for motor vehicles is one to which we believe not enough thought is given ordinarily. Practically anybody nowadays can drive an automobile. For this reason there is a tendency to minimize the qualifications which a successful chauffeur or successful truck driver should have. Basically the qualifications for chauffeur or successful truck driver should have. Basically the qualifications for chauffeur or truck driver are about the same, but the two jobs demand men of different temperament and physiques.

The basic thing in selecting men for either kind of job is that they be steady and alert mentally and fit physically. Young men are on some accounts preferable to older men, but when young men are employed, married men are usually preferable to single men on account of their more steady habits.

As regards physical condition, some companies go so far as to have all prospective motor vehicle operators examined by a competent physician to determine if their eyesight, hearing and heart action are all right. This physician's examination to some

may seem unnecessary, but on the other hand it is pretty easy to picture what an accident might occur if an operator's vision was badly impaired or if the operator was to have an attack of heart failure while at the wheel of his vehicle.

All operators should have somewhat more than a superficial knowledge of the mechanics of their units and should be competent to care for minor and roadside repairs. The more competent the operators are mechanically, the better service they will get from their vehicles and this in turn will materially reduce operating costs.

Passsenger Vehicle Drivers

Operators of passenger vehicles should be neat and clean in personal appearance and must appreciate the fact that one of their chief duties is to do all they can to add to the convenience and comfort of their passengers. Courtesy at all times is absolutely necessary, but chauffeurs must also remember that they are the skilled men responsible for the safety both of the passengers and of the motor equipment. This latter thought applies particularly to those cases in which passengers have real or imaginary appointments to keep and urge the driver to take chances which in the driver's judgment should not be taken. Under these conditions the driver must possess both executive and diplomatic qualifications which will make him master of the situation without arousing resentment on the part of the passengers.

Truck Drivers

As regards truck drivers, we have always believed there is a tendency on the part of some employers to minimize the responsibilities which these men carry. They do not appreciate the really tremendous potential possibilities for damage which the man at the wheel of a truck carries with him. A heavy duty truck, laden to capacity, will weigh gross anywhere from 10 to 12 tons. Such a unit is a literal juggernaut of death unless properly handled and controlled. As a consequence, the responsibilities which the drivers of heavy duty trucks carry are very real and are something which the driver himself must appreciate. These responsibilities are something which the management should appreciate also.

One of the biggest points in handling heavy duty equipment lies in the fact that while we know we can get any speed we want with the use of compounds and gear ratios, practically nothing as yet has been devised for quick deceleration of high speed. The engine is the best brake which the truck driver can have, but here again the driver must be thoroughly trained so as to know how to use his engine and must never taken chances. Nothing is more dangerous than the practice some drivers indulge in occasionally, that of coasting down hill with the gears in mesh and the clutch out, then attempting to decelerate the truck by slipping in the clutch. Sometimes the truck's mechanism will stand this, but usually everything lets go. Even if no one is hurt we have an attendant repair bill of anywhere from $600 to $1,000.

Another big point to be remembered in picking truck drivers is that from the minute the driver leaves his headquarters with his load, to all practical purposes he is a non-supervised employee. It should be remembered too that our companies are gauged in the eyes of the general public by whatever attitude our drivers assume. If our drivers hog the road and hog the crossings, as so many are inclined to do, and can do with safety to themselves, the public will at once judge our company to be that kind of an organization.

In addition to this, if incompetent or insufficiently instructed drivers are put on the road and have frequent road breakdowns which they are unable to handle, there is always the attendant loss of time and money to their companies. The railroads of the United States in selecting and training engineers always stress the point that the engineer is the sole custodian of thousands of dollars worth of equipment and of any number of lives. We believe this point should be realized amongst motor vehicle operators, too.

The two slogans which we believe every motor vehicle operator should always keep before him are "Safety First," and "The load must go through."

Education and Prevention of Accidents

By W. H. FAIRBANKS and D. A. RUNYARD

The subject of education and prevention of accidents covers a broad field. We, of this section, are naturally particularly interested in the prevention of shop and transportation accidents. However, rather than discuss this particular phase of accident prevention, we have thought that it might be of more interest to the members of this section if we were to tell them of the campaign, along general accident prevention lines, which member companies L and M, together with their associated companies throughout the United States, have been going through for the past two or three years.

Accidents in industry may be viewed from two different angles; one angle being the humanitarian side, and the other angle being the cold blooded point of view of loss in efficiency and dollars wasted. From whichever angle it is viewed, the subject of accident prevention is recognized as a subject well worth the most careful consideration and action. The companies referred to have recognized this and attacked the problem from two separate angles, namely, education of employee personnel in first aid methods, and education in safety first measures to reduce accidents.

The first aid campaign was started first and was followed very closely by the safety first campaign. In general, these campaigns were handled as follows:

First Aid Campaign

At all of the larger centers certain employees were picked out and, on company time and at company expense, were given a course in first aid training which lasted about a week. After the completion of this course, they were given an examination and, if successful in passing the examination, were awarded an American Red Cross certificate of proficiency. These men then returned to their individual locations, whereupon each man at once proceeded to organize a class in first aid training. The classes numbered from 15 to 20 men per class.

These classes covered about 10 lessons and were held after working hours on the employees' time. As fast as one class completed its work another was formed. Interest and enthusiasm were encouraged and stimulated by means of first aid contests between teams representing various localities, these contests being sponsored by the company and much interest being aroused in them. For the first year or so of this first aid educational campaign, enrollment in the classes was voluntary and no particular steps were taken to force employees to take this work. As the situation developed and as new employees were gradually added, these companies have practically made it a condition to employment that each employee must agree to take this first aid training.

Safety First Campaign

The safety first campaign was started very shortly after the inception of the first aid campaign and interest was stimulated by handling it largely as a competition between various localities, districts, divisions and companies. All accidents were divided into two classes, the first known as disability accidents, where time was lost from the job, and no-disability accidents, these latter being minor accidents with no lost time. The standing of the various communities, districts, divisions, etc., was gauged by their number of lost time accidents. A chart was published in the company's house organ showing where each major subdivision stood as compared with the other subdivisions. This campaign was actively assisted by the company. One of the first steps taken was the elimination of all unsafe conditions which could be found.

To aid in the study of these conditions, safety first committees were formed among the employees. These committees were charged with the duty of reporting to their supervisors any unsafe conditions which existed in the plant.

The history of these safety committees is somewhat interesting. All of the men on the committees took an intense interest in their work and very many valuable suggestions were received from them, these suggestions many times covering unsafe conditions which the supervisors had overlooked. After a period of time, however, the bulk of these unsafe conditions were cleaned up and from then on the committees were forced to pick on any little thing they might see. As a rule these little things were only a question of judgment with nothing vital involved. This situation in time led to the doing away with the safety committees. The good which these committees accomplished while in existence was very real and very marked.

Another very interesting thing which this safety campaign developed was the fact that one of the hardest things we have to do is to try to protect men from the results of their own carelessness. All accidents are carefully analyzed and, so far as is humanly possible, the blame is placed where it belongs; that is, on the employee injured, on fellow employees, on the company, or on some occasions on just plain hard luck. At the start of the campaign, and one or two other occasions, somewhat drastic action was necessary to impress on the employee the need for carefulness. One such instance occurred in my own department and I believe it is worth repeating.

About two years ago the disability or lost time accident record for my department looked rotten. We were running from 8 to 12 lost time accidents per month despite all preachments and precautions. I waited until an accident occurred which seemed to me a clean cut case of one in which men were hurt from their own carelessness. When this accident did occur the men were sent first to the doctor and then to the hospital. The doctor bills and the hospital bills were paid for them in full and they were paid full wages for all the time they were off on account of their injuries. After these men were fully recovered and had returned to duty, I discharged them for the carelessness which had resulted in the accident. The men naturally thought they were terribly mistreated, demanded an investigation from my superiors and asked for re-instatement. There were, of course, certain features in favor of their contention that they had been unjustly laid off but throughout the entire investigation I stood fast on the ground that I was going to stop accidents from carelessness, no matter what it cost. When the smoke of the investigation finally died away, the men still remained discharged, and since then the disability lost time accidents of my department have dropped from 8 to 12 per month to from 0 to 2 per month and have remained there ever since.

Auto Accident Prevention

As regards education and prevention of accidents in handling automobiles, one excellent system is that which provides that every accident be carefully investigated by a chief special agent's office, or some office independent of the operating departments, and a report made to the department head as to who is at fault in the accident. Member company M operates under such a system and I run in my office, for my personal information, a card file covering every employee in my department who has ever had an accident, a record of the accident, and whether or not the employee was at fault. I have never directly said anything on this but it is generally understood among all drivers that wherever a man's card comes to show too many accidents with the record showing him at fault, he automatically discharges himself. This is so generally understood that our avoidable accidents are very few and far between.

Another excellent measure to discourage automobile accidents is to refuse to "square" traffic tags and to have it a generally understood rule that all employees who get traffic tags must care for them personally. There are, of course, some instances where the driver will receive a tag on account of solid tires bumping or not enough rubber on solid tires. Cases like this are not, of course, the driver's fault, and we take care of the tag for him. Under practically all other conditions, we do not attempt to handle tags.

The first aid campaign and safety first campaign being carried on by member companies L and M has been under way about three years and has achieved really marvelous results. The present percentage of disability accidents is only something like twenty-five per cent of what it was when this campaign started. From a humanitarian point of view much pain and suffering has been saved to the individual employees and their families. From the cold blooded business point of view, the loss in efficiency and dollars wasted due to accidents has been greatly cut and best of all it is apparent to all of us that the individual employees are much more contented when working under the safety first plan. Another very interesting thing is that while the working out of this scheme of course has cost something in time and thought, the actual efficiency of our forces has been increased and really somewhat speeded up rather than slowed down.

Public Relations Section Report

Customer-Ownership Committee Report*

Past, Present and Future of Customer-Ownership Activities on Pacific Coast

The committee on customer ownership has prepared as its report for the past year a brief resume of the customer ownership plan as pursued by the power companies of the Pacific Coast, with a few suggestions as to its promotion and the general lines of policy that should be followed.

The customer ownership plan of marketing junior securities had its inception in June, 1914, when the Pacific Gas and Electric Company offered its preferred stock for sale direct to the public. The plan met with immediate favor among small investors, particularly among customers and employees. Gradually it was adopted by other utility companies on the coast until at the end of 1925, practically all of the utility companies were using this means of placing a substantial portion of their junior securities.

A prominent economist has said: "The forms which ownership of property takes in any society are of fundamental importance in determining its social and economic institutions."

Our American social and economic institutions represent the highest development of civilization. They are the inspiration of our forms of property ownership, if we are to accept the economist's conclusion as a truism, and they have been from the beginning constantly subject to change as there have come about changes in those forms. Basic laws are, of course, inflexible, but new interpretations must be

*F. V. Boller, San Joaquin Light & Power Corporation, Chairman. R. H. Seward, Great Western Power Company. W. H. Kamm, Coast Counties Gas & Electric Company. H. E. North, Western States Gas & Electric Company. K. G. Coutchie, Coast Valleys Gas & Electric Company. E. B. Criddle, The Southern Sierras Power Company. F. E. Seaver, Los Angeles Gas & Electric Corporation. F. L. Greenhouse, Southern California Eodison Company. E. J. Beckett, Pacific Gas and Electric Company. D. G. Tyree, California Oregon Power Company. M. B. Fowler, San Diego Consolidated Gas & Electric Company.

given them from time to time, they must have new application, and there must be deeper understanding of them to make changing conditions of society conform.

Economic Revolution in Progress

Commenting recently upon a sign he had seen displayed by a Western city, inviting the public to become partners in the ownership of a certain utility, Albert W. Atwood, widely known as a writer on business and economic topics, said that it is perhaps true that we are passing through a swift, silent, peaceful and unheralded revolution. Behind this revolution stands the diffusion of ownership and equalization of wealth which the spread of securities of corporate industries among the citizens at large is bringing.

"So rapidly and quietly has the change come about," says Mr. Atwood, "that those who still prate about the rich growing richer and the poor growing poorer are talking about conditions which are fast passing, and exhibiting a state of mind which is largely a hang-over from earlier times."

Even more recently, in an article on Customer Ownership appearing in the New York Commercial, A. Emory Wishon of California, chairman of the National Electric Light Association's Customer-Ownership Committee, said:

"After all, customer ownership is a logical development of the times. This is a period of co-operation, of mergers, and of recognition of the folly of waste and wasteful competition and of the superior efficiencies and economies brought about through business combinations. Modern life is too complex, its problems are too involved for the average individual to stand alone to meet them. Hence the average individual of necessity goes along with its fellows, joining in such business partnerships as are safe and sound. He is merely playing his part in the great business movement of his day."

Diffuse Ownership Created

Obviously there has come in recent years through customer ownership a change in the form of property ownership—the wider diffusion of ownership discussed by Mr. Atwood. And while that change has brought with it the millions of the masses to help in the developing of American business, it has also brought to business the opportunity to give to the masses a better understanding of its purposes, its policies, and its sincere desire to serve.

The sale of securities to the public, our customers and employees, has assumed as its angle of chief value the promotion of better public relations. The first and all time purpose in the sale of securities was to obtain money for betterment expenditures. Now, however, while we recognize that a vast reservoir of capital has been made available to us, the better public relations with the public through the intimate and understanding contacts customer ownership has created, have made its financing aspect relatively much less important.

Until quite recently, the growth of industrial capital was confined to increasing the holdings in the possession of comparatively few men, but since we have begun to recognize the virtue in the movement of joint stock ownership, participated in by small investors, business, which includes public utilities, seems inclined to foster and further this popular financing principle. This change in the mode of financing was actuated by the belief that greater success will be achieved by the business that finds among the users of its products, the greatest number of its shareholders.

Sales Effort Less Active

A study of reports received from utility companies would indicate that there has been, particularly among companies throughout the East and Middle West, a recent tendency to depart from the customer-ownership plan. Although the utility companies of the West have adhered much more closely to the plan, the reports show that the increase in the amount of securities sold and number of new stockholders obtained by some of the companies has not maintained the same percentage as shown during the first few years of their stock sales activities.

This slackening of effort, we believe, is logically due to the fact that money has been plentiful and large blocks of securities could be marketed in a short length of time by placing them through the bond houses. Some of the companies, having construction programs that did not require large sums of new money, sold out their issues during the first few months of the year. During the remaining months they attempted little or no customer ownership promotion.

Uniform Accounting

Reports received from the various companies show rather wide variations in the costs of stock sales. It is thought that this variation in costs can be attributed to the lack of a uniform method of accounting in connection with stock sales activities, and it is the suggestion of your committee that such a uniform method be adopted, in order that these various costs may be intellligently studied by member companies.

Use of National Association Files

It is suggested that member companies make more use of the customer ownership files kept by the National Section in New York. These files contain much valuable data, gathered by the National secretary and available to any of the member companies.

Replies to Inquiries

The executives of the stock sales department of the various companies are continually being called upon for statistics and asked to fill out questionnaires. It is the committee's suggestion that the various companies submit, semiannually or annually, the data which are now furnished the National Section yearly through their stock sales questionnaire, and that all inquiries for these data should be referred to the national headquarters.

Selling Methods

Various methods of selling on the customer ownership plan have been tried out by the different companies, but it is the consensus of opinion among those companies whose activities have been most marked along these lines, that the greatest success can be achieved through a combination of employee salesman and professional salesmen.

Keeping in Touch with Stockholders

It does not seem to be a uniform practice among the companies to keep stockholders advised as to the activities of the company, and it is suggested that the stockholder list affords an excellent opportunity to further public relations by the publication of a bulletin, either monthly or quarterly, in which information as to the utility's construction programs, etc., would be set forth.

Refunds for Installment Buyers

It is recommended that companies should make it as easy as possible for stockholders purchasing small lots on the installment plan, to obtain refunds, either partial or whole, and either by re-sale or otherwise, in case such a necessity should arise. A great many small stockholders consider the purchase of utility securities in the nature of a savings account, to be drawn upon in emergency, and if we are to continue to build up our Customer Ownership list from the ranks of the small investors, serious thought must be given to this phase of the relationship.

The Ten Cardinal Rules

Attention is drawn to the "Ten Cardinal Rules of Customer Ownership," prepared by the customer ownership committee of the National Section in its report for the year 1925. These rules embody the fundamental principles of customer ownership policy and promotion, evolved after careful study and embodying the analytical opinions of outstanding leaders of the industry. They are sufficiently general in their scope to permit each individual company to meet its particular problems under them, and sufficiently specific to serve as a guide to successful operation of the Customer Ownership plan.

Statistical Report

The reports received by the committee do not contain a complete record of all the activities of all the companies but as an indication at least of what has been done by some of the larger companies of the West under the customer ownership plan, the following figures are submitted:

Name	Number Stockholders	Par Value
Los Angeles Gas & Electric Corp.	10,321	$ 19,220,700
Pacific Gas and Electric Co.	39,592	51,000,000
Great Western Power Co.	9,265	13,027,000
Southern California Edison Co.	83,000	85,910,200
San Joaquin Light & Power Corp.	12,350	11,878,900
	154,528	$181,036,800

Advertising-Publicity Section Reports

Book of Standards*

Organization, Scope, Functions and Purpose of the Section

Part I—Organization and Procedure

A—Purpose

The Advertising-Publicity Section is dedicated to the study of advertising and publicity matters as related either individually or co-operatively to all members and member companies of the Pacific Coast Electrical Association.

This study shall be directed to the end that such advertising and publicity efforts shall be of the greatest benefit individually to member companies and mutually to all branches of the industry.

Nor shall this study or activity be limited to any particular type of advertising or publicity effort, but shall include a study and activity in all phases of such publicity and advertising effort as may be found helpful.

This section shall strive to improve the technique of advertising copy by this study. It also shall seek to advance its usefulness.

Likewise the section shall set forth the ethical principles which shall guide members of this section in their advertising and publicity practices.

B—Scope

The advertising and publicity study and activity of this section shall be conducted not only upon commercial advertising, but upon institutional, public relations, financial or any other forms of advertising or publicity engaged in by member companies. All legitimate forms of advertising or publicity also shall be sought for and developed.

While not interfering with the advertising study or programs of other sections of the association, this section shall place itself at the disposal of those sections that may carry out for them or assist in their advertising and publicity efforts, lending to those sections the experience and fitness of the membership of this section for such works.

It is to be hoped that other sections of the association will avail themselves of the Advertising-Publicity Section's co-operation. Logically, this section should be the clearing house for all such activity within the association.

C—Membership

Any member of the Pacific Coast Electrical Association whose duties in whole or in part give him responsibility in the advertising or publicity activities of hs company may become a member of ths section.

Space will be provided upon the membership application form of the Pacific Coast Electrical Association giving the applicant an opportunity to signify his desire to belong to the Advertising-Publicity Section.

Committee and department personnel may be made up from a list of members assigned as belonging to this section and furnished by the secretary of the association.

It is desirable that the activities of the section be engaged in by as many members as possible. Also it is desirable that the work of the section be so distributed that too great a burden may not be placed upon any few members, nor that all opportunities for self-expression be given to only a few members who have proved good workers in the past.

Variety and freshness of viewpoint are such valuable attributes in the performance of this section's activity that every effort to stimulate these qualities should be encouraged by a widespread assignment of papers, problems and labors among the membership.

D—Officers

Selection.—The officers of this section shall consist of a chairman, a vice-chairman and a secretary.

The chairman shall be selected according to the rules and practices of the Pacific Coast Electrical Association, whatever they may be.

The vice-chairman and secretary shall be appointed by the chairman.

Duties.—The chairman shall preside at meetings and be responsible generally for the conduct of the section during the period of his incumbency. He shall act upon the executive committee for one year after his chairmanship ceases.

The vice-chairman shall assist the chairman wherever required and in the absence of the chairman preside over meetings in his stead.

The secretary shall keep the minutes of the section and attend to such correspondence or other clerical or detail duties as concern the section. He shall furnish also to those members to whom a copy of this Book of Standards has been assigned an account of the minutes of each meeting, prepared in loose-leaf form to conform with the style of the Book of Standards. These he shall dispatch as soon after the meeting as possible that these reports may be kept for reference by members at all times.

E—Standing Committees

To carry on the administrative functions of the section there shall be three standing committees as follows:

1. Executive committee.
2. Standards committee.
3. Information committee.

These committees shall be organized as outlined in paragraphs following.

1—Executive Committee.

Personnel.—This committee shall consist of the chairman, the vice-chairman, and the retiring chairman of the section. The latter shall bring to this group the experience gained in the activity of the past year's administration in order that the current year's work of the section may be in conformity with, and supplemental and continuous to previous work of the section.

Duties.—It shall be this committee's duty to consider and to take action upon all executive functions of the section.

Powers.—It shall set in motion whatever section motions or resolutions are considered by it as valid, or which, submitted to the standards committee, shall be found to conform with section standards.

It must decide upon action of any nature as recommended by either the membership at large or by the standards committee.

It shall review the year's program and assign the study and activity of the section for the year as described in section F of this manual.

2—Standards Committee.

Personnel.—This committee shall consist of three members, the junior member to be appointed each

*Prepared by the Standards Committee. B. S. Allen, Key System Transit Company, chairman. Journal of Electricity: W. A. Cyr. Pacific Gas and Electric Company: J. C. Jordan.

year by the executive committee to serve a term of three years. The senior member shall serve as chairman of this committee.

Duties.—The standards committee shall constitute a judiciary body, responsible for the establishment and the interpretation of the standards of practice of the section.

Any changes or additions to the code of standards shall be submitted to it for decision as to conformity with the ethical principles set forth by the section. The standards committee shall have no executive power, but shall make whatever recommendations it deems advisable to the executive committee or to the membership at large for their action.

The standards committee shall remain always an advisory body.

Media.—Media of questionable merit submitted to the individual members of this section or to member companies, and yet upon which the member may not desire to disapprove upon his own responsibility may be submitted to the standards committee for examination and recommendation.

An examination then shall be made by the standards committee into the value of such media according to the standards set forth in Part II of this manual. The standards committee in such cases will examine into the merits of the medium presented, its circulation, field, influence, class and policy and submit a report upon it to the member or members affected by it.

Action upon such a report then shall be left to the discretion of the member who has submitted the medium for report.

In a similar manner the publisher of a periodical or special edition, if he feels that his publication is worthy of advertising patronage, may submit it to the standards committee for examination. Upon such publication a similar report will be made to the members or member companies which may be interested in such a decision.

It then shall rest within the discretion of those members whether or not such media shall be used, the standards committee's recommendation being designed as a guide to such final action.

The standards committee in all respects shall contribute an impartial judgment, unbiased and uninfluenced by local conditions.

Manual.—The standards committee shall be responsible for the upkeep of this Book of Standards, furnishing revised pages as they become necessary to those to whom books are assigned in each member group or member company.

3—Information Committee.

Personnel.—The information committee shall consist of a chairman, appointed by the executive committee, who shall in turn appoint such members as he requires to carry on the work of his committee. This committee personnel shall be so arranged as to provide a member of the committee in each population center to whom local inquiries for information may be submitted.

Duties.—This committee shall be charged with the responsibility of having available to whoever may desire it such information concerning the industry as may be called for.

To this end the committee shall have a representative in each natural center of population who shall be responsible to the committee and to whom requests for information may be directed. Presumably such representative shall be with the local central station company.

If these representatives, after diligent thought and careful research through all the means at their hands, cannot supply the desired information they shall refer the request promptly to the committee chairman, who may enlist the assistance of any or all members to furnish the required information.

Speakers.—This committee also shall be prepared to furnish speakers on subjects dealing with the industry, at the request of responsible individuals or public groups. Information for these speakers or for other speakers who may request such information material also shall be furnished by the committee.

This committee, in short, shall strive to be of assistance to all member companies in a proper collection, co-ordination and dissemination of information.

F—Work of the Section

1—Departmental.

Departmentalization.—At the beginning of the term or at any occasion which may require such action the executive committee shall create departments to conduct the research work of the section for the year. The leadership of such departments shall be assigned to some particular individual member considered by the executive committee as being best fitted to undertake the task. He shall be known as the department editor, responsible for the presentation to the section of a careful analysis of that particular study to which he has been assigned. The department itself shall be made up of the editor and such other members of the section as he may name to assist him.

The work of a department shall consist of gathering together information and preparing a report upon the subject assigned to it at the specified time set by the executive committee.

For purposes of concentration it is considered advisable that the number of these departments be limited.

Department Meeting.—Each department shall be made responsible for a program of study at one of the regular meetings of the section.

At its particular meeting the department shall strive to present to the assembly something in the nature of a symposium on the subject assigned to the department. Papers prepared by individual members of the department may be read. In many cases speakers from outside the section or even outside the association, but competent to present some particular phase of the department study, may be heard. Indeed this practice should be encouraged since it should lead to a broadened viewpoint as to the particular subject under discussion.

It should be the aim of each department to bring before the membership at its particular meeting as completely exhaustive a survey of the subject as possible. Each phase of the department's assigned topic should be dealt with intelligently and thoroughly to the end that the membership may gain from these programs the greatest potential knowledge and usefulness.

Annual Reports.—Each department editor then shall be charged with the responsibility of summarizing and editing the best thoughts and practical ideas presented in his program, this summary to constitute the serial report of his department to the section. These reports then shall be in the form required for publication in the annual proceedings of the association. They also shall be available to the section chairman for summary or special mention in his report to the association on the activities of the Advertising-Publicity Section for the year.

Dismissal. — Upon satisfactorily completing its program and report to the section, the department shall be dismissed and its work considered finished. In those instances in which departmental study should be carried over from one year to the next the executive committee of each new year shall departmentalize the work anew, possibly retaining the entire department personnel of a previous administration or at least some of its most active members; at least those who are best acquainted with the previous study and hence in a more logical position to carry it on advantageously.

2—Annual Report.

Form.—The particular form in which the annual report of the section to the association shall be presented at one of the general sessions of the association annual convention shall be decided upon by the executive committee.

In general it shall consist of a summary of the work of the standing committees and of each of the departments, such particularly interesting features of the latter as seem vital to an understand-

ing by the entire association to be given prominence as pleases the chairman.

Supplementary. — Wheiever possible the section shall strive to present at the convention, aside from and supplementary to the annual report, eitner a paper, speaker or display of some effective character. This paper or display should be decided upon by the executive committee and arranged for as early in the year as convenient to allow ample time for its preparation.

3—The Book of Standards.

Form.—The Book of Standards shall be prepared in a loose-leaf binder of letter size. The binder shall be of black, limp, grained leather. Upon the outside front cover of the binder the words, "Book of Standards, Advertising-Publicity Section, Pacific Coast Electrical Association," shall be embossed. The name of the member company to which each copy is assigned also shall be embossed on the cover.

The pages containing Parts I and II of this manual shall be of a good grade of bond stock, and of appropriate size. The content of the book shall be printed. A separate page shall be given each item so that changes may be made without rendering obsolete the entire book, merely the page affected being removed.

Preparation and Upkeep.—The standards committee shall be responsible for the preparation, editing and upkeep of pages for the Book of Standards, furnishing new pages to holders of copies of the manual whenever some change in it is authorized by the executive committe or membership.

Assignment.—One copy of this Book of Standards shall be prepared for each member company of the Pacific Coast Electrical Association. The secretary of the section shall keep a record of those to whom copies of the manual have been issued.

Other copies may be secured by members or member companies upon proper request. The member shall furnish his own binder, the section furnishing the pages therefor.

Minutes.—Minutes of the meetings of the section shall be prepared by the secretary of the section to be incorporated in the Book of Standards, Part III. Minutes shall be prepared by mimeograph or other suitable process, and on paper punched to fit the binder adopted.

Use of Book.—The Book of Standards shall be kept at hand by the advertising and publicity representatives of member companies for ready reference. The book is designed as a useful tool for the member and should not be filed in the library or other repository of records and forgotten. It should prove especially useful for reference in cases of solicitation for special editions or other irregular media. It may be used to demonstrate the stand of the industry upon questions relating to truth in advertising and honesty in merchandising, and should be used in this manner by members at every opportunity.

Except that it is used, all efforts to produce it and to maintain it will become wasted and unproductive effort and such is diametrically opposed to the spirit in which it is issued.

G—Procedure

1—Regular Meetings.

Regular meetings of this section shall be divided into a business session and a department-program session, as described in Section F 1 of this report.

Business Session.—The business session shall be held for the purpose of considering any business matters, preliminary reports, or reports of standing or special committees, passing of resolutions, or other activities as may be necessary to the conduct of the section.

The order of business shall be:

1. Meeting shall be called to order by chairman. The secretary shall check the roll of those present.
2. Reading of the minutes of the previous session by the secretary followed by a discussion and disposition of the minutes.
3. Introduction of new members and guests.
4. Reports of the standing committees:
   a. Executive
   b. Standards
   c. Information.
5. Reports of special committees or preliminary reports from departmental editors.
6. New or old business and the disposition of it.
7. Announcements.
8. Determination of the next meeting place and date.
9. Adjournment until the department program session.

Department Program Session.—These sessions, after being called to order by the section chairman, shall be turned over to and shall be in charge of the department editor. He shall announce the subject for the presentation of which his department is responsible and summarize the work of the department on the subject.

He then shall announce and present each speaker in turn and at the conclusion of each paper or address strive to show how the thoughts presented bear upon the subject under discussion and a solution of its particular problem. He may call upon members present for informal discussion of any particular phase of the subject presented.

At the conclusion of his program the department editor shall turn the meeting back to the section chairman for such action upon that which has been presented as may seem fitting or necessary.

2—Executive Committee Meetings.

Executive committee meetings may be called at the option of the section chairman. This committee shall have the power to act for the section upon any matters upon which the members of the committee are in accord.

3—Standards Committee Meetings.

Meetings of this committee may be called at the option of the chairman or upon direction either from the membership of the section or from the executive committee.

Likewise these meetings shall be informal and conducted in such manner as will promote most effectively the work to be considered; yet they shall be made as convenient as possible for all members of the committee with respect to their regular work.

When a medium is presented for judgment, members and member companies or other reliable sources of information concerning the medium shall be enlisted to provide as clear and unbiased an understanding of the case as is practicable. This work of investigating any particular medium may be undertaken by one of the members of the committee who shall report his findings to the combined committee for its final report.

At the Convention

At least one session shall be requested by the section from the convention program committee. If necessary more than one session may be asked for, according to the subjects to be considered. These sessions shall be conducted as open meetings. In many cases indeed it may be deemed advisable by the executive committee to hold the convention meetings as departmental program meetings, presenting some particularly important topic for the symposium at the convention session so that delegates to the convention may avail themselves of the opportunity to hear such a problem discussed from all of its angles.

Part II—Standards of Practice

I—Truth in Advertising

This section subscribes heartily to the principles set forth by the Advertising Clubs of the World with respect to truth in advertising.

Although these principles have been given expression in many instances, there seems to be no definitely stated code setting them forth. The cardinal principle enunciated is that all advertising and merchandising shall be truthful.

However, these principles as applicable to our industry and taken from the program of the Better Business Bureau of the Advertising Clubs of the World, may be expressed as follows:

Code.—In the conduct of their several advertising, merchandising and publicity efforts members of this association, and particularly this Advertising-Publicity Section, shall:

Urge the public to investigate before investing, and to investigate before signing agreements.

Protect the buying public against deception and possible fraud in advertising and merchandising by investigating and correcting wrong practices.

Persuade individual firms to discontinue unfair tactics that work to the disadvantage of competitors and which, moreover, tend to throw the industry into disrepute.

Remove unjustified suspicion and misunderstanding between competitors by getting the facts regarding suspected advertising and merchandising practices and reporting upon their real character.

Increase loyalty and spirit of employees of member companies by having them know that this industry is participating in the "truth in advertising" movement.

Help an advertiser to make his printed announcements more believable and productive, and in all cases strive to turn unscrupulous advertisers into fair dealing advertisers.

Co-operate with honest business institutions to help them remove confidence-destroying spots in their own advertising and merchandising.

Reduce the burden of unjustified public suspicion which through misunderstanding may react upon the advertising or merchandising of any institution.

Increase public confidence in all advertising and merchandising by co-operating with the advertiser to represent correctly his goods and the conditions under which they are sold.

Protect public confidence in member-companies' individual business communities as reliable trade centers so that buyers in the surrounding territories may feel that they get value received in those communities.

Seek to create maximum public confidence in every recognized form of advertising; out-of-doors as well as newspaper, magazine, direct-mail, etc.; by making all member companies' advertising trustworthy.

Seek to conserve the efficiency of employees in member companies by investigating promotion schemes in which such employees are solicited to buy stock or merchandise through the misuse of advertising or through misrepresentation.

Promote state and municipal legislation for the better protection of legitimate business and the public from abuses in advertising, but, when flagrant misuses of advertising must be prosecuted, use legal action only as a last resort after all efforts to educate have failed.

Favor making adjustments with purchasers dissatisfied by reason of unfortunate experiences with advertised goods or service, at the same time taking advantage of the opportunity to educate the erring advertiser to better methods and to impress on the individual customer, if possible, the integrity of most business concerns.

Take the steps necessary to protect the public and legitimate financial institutions from fraudulent stock promotions, conserving money in legitimate business channels in the interest of business generally and maintaining the confidence of the public in the advertising of worthy investment securities, especially those of public utilities.

II—Special Editions

This section condemns the practice of patronizing special editions, special advertising pages, annuals, programs, commercial house organs, association publications, novelties or other forms of irregular or unorganized advertising or publicity. This section also favors the practice of supporting associations or organizations by memberships or by specific contributions, when warranted, rather than by asking those members responsible for advertising placement to give support to such institutions by advertising patronage which lays them open to solicitations from every source.

This section prefers to advertise regularly and methodically through such organized and stabilized media as its appropriations for advertising will permit.

The resolution adopted by this section on this subject is as follows:

Resolution Condemning Special Advertising Pages and Editions

Inasmuch as there has arisen a growing tendency among newspapers and periodicals to publish special advertising pages and editions on nominal pretexts; and furthermore,

Inasmuch as these special pages and editions are fo small advertising value and are a heavy drain upon funds which otherwise would be used in profitable, organized advertising effort; and furthermorè,

Inasmuch as solicitations for the sale of space in these special pages and editions very generally are conducted by irresponsible persons with only temporary connections with the publishers they represent and along very irregular lines, often using assumed sales as arguments and the established commercial relations of their prospects as a means of compelling the purchase of space; and furthermore,

Inasmuch as cases have been cited where established commercial relations of great importance have been endangered by the methods used by special-page or edition salesmen soliciting our own members; therefore

Be it resolved: That this Advertising-Publicity Section of the Pacific Coast Electrical Association hereby condemns the practice of publication of special pages or editions which are dependent upon the sale of special one-time advertising space; and furthermore,

Be it resolved: That this Advertising Section of the Pacific Coast Electrical Association hereby also condemns the practice of employing special solicitors for the purpose of selling or promoting special pages or editions and who care little for the general welfare of the paper represented and less for the interests of the prospective space buyer; and furthermore,

Be it resolved: That, since this Advertising Section has an established standards committee whose duties call for the investigation and analysis of advertising media, members of this section may submit to the standards committee any medium of a special character for examination by the standards committee, which committee shall value impartially the worth of such media and make appropriate recommendations for the guidance of the membership in each case.

Art in Electrical Advertising

By S. W. GREEN*

Man's first written language was in pictures. Written words were developed only after ages of tedious toil by people who used conventionalized pictures to form letters.

While modern thought owes much to written language the shortest appeal to all minds is through a picture. Pictures are impressive because they are primitive. The wide appeal of the motion picture today is only mankind's reversion to his primitive love of pictures. Pictures convey thought messages with the least mental exertion.

Because of the tremendous power of the picture in thought impression and transmission there is every argument for the fullest use of picturized illustration in advertising the electrical industry.

Electricity is the newest force to be brought under control by mankind. Into its discovery and development is woven a new romance that surpasses the wildest dreams of the ancient romancers. It is a part of all that is new and active in our everyday life. During the few years of its development and use it has wrought wonders far greater than have taken place in all time past. It has opened up new possibilities of achievement for those who are ambitious, those who desire to do big things; it has lifted the loads from the shoulders of millions of toilers; it has made possible undreamed of forms of entertainment and recreation. It has shortened time, made seconds valuable, speeded up our old world. It is the most potent force for the benefit of mankind that ever has been devised.

With so much to be said about electricity and its uses and so little time in which to say it there arises the necessity of telling the story in pictures.

But what kind of pictures?

As well ask the virtuoso what kind of tone must he use to lure a sonata from his Stradivarius.

Use the picture that tells the story, whether it be a bent line to show rising costs, or a full-color masterpiece to depict a drama. Only the experience of the trained artist can guide in the proper selection of illustrations.

Little is left to be desired in modern art. Behind is the gradual development of art sense that has grown with civilization. Modern inventive genius has provided means for the reproduction of pictures that are practically without limitations in conveying every stroke of the artist's brush, every shadow of the camera.

But one thing is necessary for effective art, that is the idea or thought behind it. Give ten thoughts to the picture to one for the text and you increase your attention value a hundredfold.

* Department Editor, Advertising-Publicity Section, P.C.E.A.

IDEAS FOR THE CONTRACTOR

Country Club Has Unique Electric Installation

Electric Air-Heating Throughout, Kitchen with Electric Ranges, Are Features of Modern Clubhouse

Probably one of the most complete electrically equipped clubhouses has been completed at Hacienda del Orinda, 10½ miles from Oakland, Calif. It is a unique creation in country clubs. It is heated electrically throughout, and the kitchen and grill are equipped with electric ranges and broilers. The water is heated electrically, and electricity also performs many other tasks.

The building has been planned carefully to serve the members of the club with the greatest possible efficiency. The main floor contains a spacious lounge. On either side of this are the dining room and the library. The veranda is completely enclosed and extends the entire length of these three rooms. It also will serve as a supplementary dining room. The office and check rooms are across from the dining room.

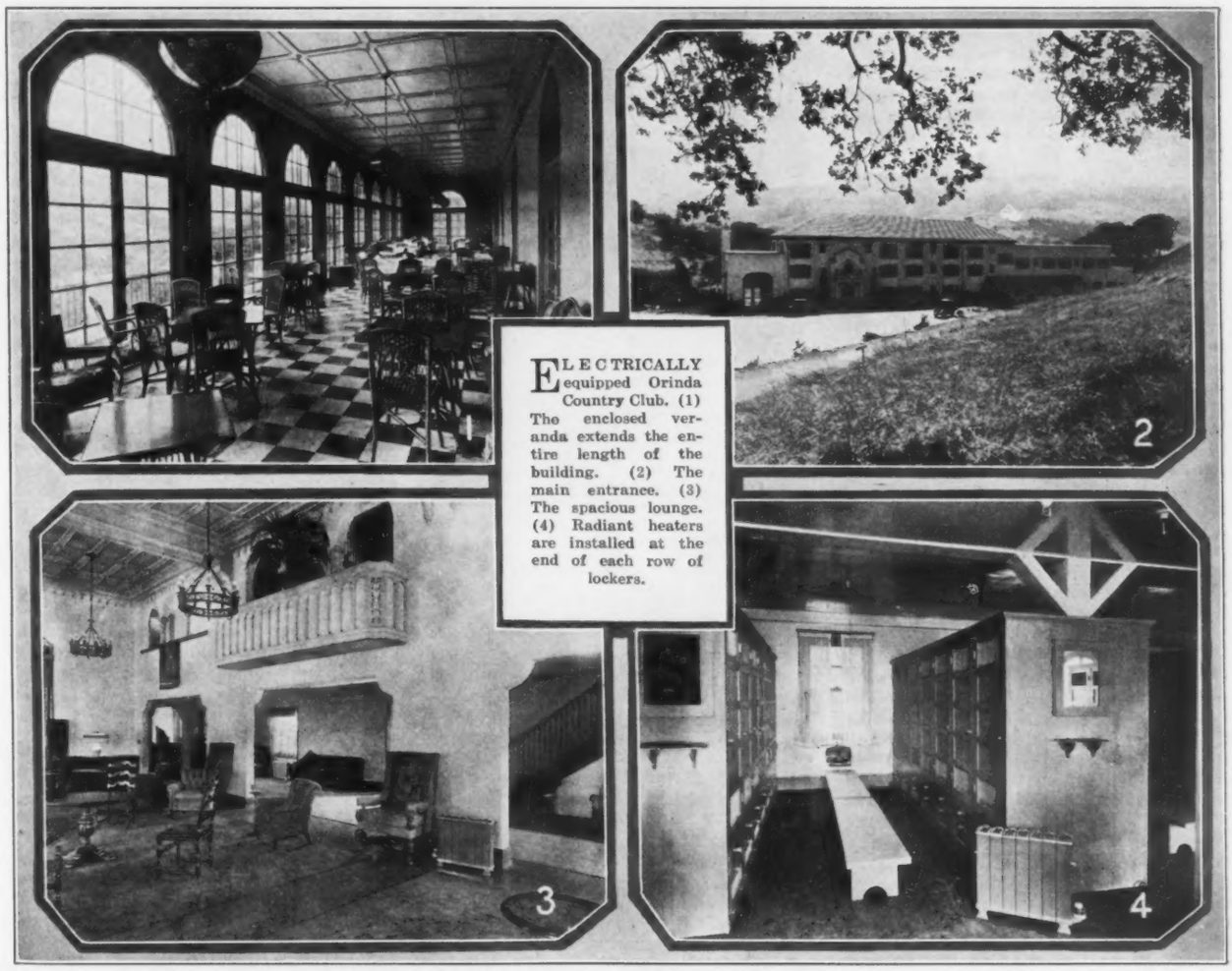
The pantry and kitchen are located at the end of the dining room. Although the men's grill adjoins them, it is completely equipped to render service independently of the kitchen.

The mezzanine floor is devoted to the convenience of the ladies. It includes a lounge room, locker and dressing rooms. The second floor is divided into living rooms, each equipped with bath.

The lockers and showers occupy what is known as the basement, although it is on a level with one of the entrances. The sub-basement is used by the golf professional and the caddy master. It also houses the refrigerating plant, the heating plant and storage rooms.

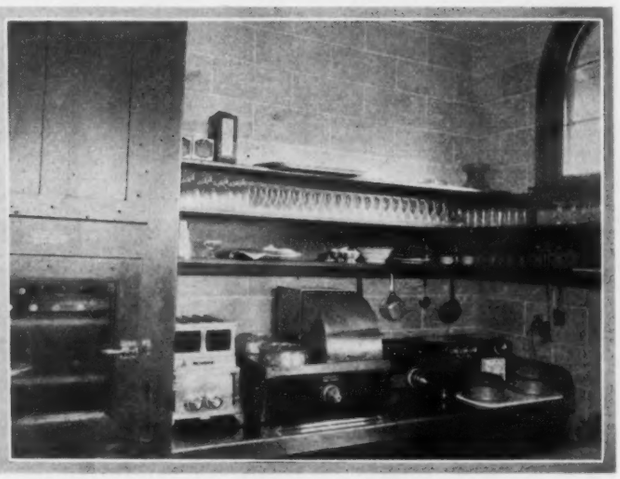
The electric installation is a notable one where comfort and convenience were paramount and economy was essential. The development of electric devices and the extension of electric transmission lines have made the use of electricity universal, gradually supplanting every other form of energy. This condition is exemplified well in the Orinda Country Club.

Engineers of the Magnavox Company of Oakland determined the size and location of the air heaters used. Electric heating installations always should be so planned that ample heat always will be available. The theory underlying the use of air-circulation heaters is based on the assumption that a room will be warmed quickly with full heat. After this condition is obtained the heat will be maintained



ELECTRICALLY equipped Orinda Country Club. (1) The enclosed veranda extends the entire length of the building. (2) The main entrance. (3) The spacious lounge. (4) Radiant heaters are installed at the end of each row of lockers.

Electric broiler, two ranges and baking oven included as part of the equipment in the kitchen.



The men's grill is completely equipped to render service independently of the kitchen. A portion of the electric equipment.

at a uniform temperature by a reduction in the amount of heat applied. This is a more economical method of heating than the installation of heaters of a smaller capacity, necessitating their being on high-heat position at all times.

In determining the heating equipment for any installation many conditions should be considered by the engineer or contractor including the location, the construction of the house or building, whether or not the foundation will be open or closed, the amount of glass exposed to the outside and the location of this glass. A complete heating installation which will be satisfactory should be made and not a makeshift job. This is a problem with which every electrical contractor should be familiar.

Magnaray electric air heaters are used throughout the installation. The majority of them are 5-kw. portable air-circulation type heaters. The bedrooms are equipped with 2-kw. heaters of this type while the bathrooms contain 1,000-watt insert radiant-type heaters. In the locker rooms a 1,000-watt insert radiant-type heater is installed at the end of each row of lockers. These heaters are designed to provide localized warmth for a comparatively short length of time while a person is dressing. Each heater is controlled separately and can be turned on or off at the pleasure of the guest. This provision eliminates the necessity of keeping the entire locker room at a moderate temperature at all times. Several air-circulation type heaters of 5-kw. capacity are used to take the chill from the air in the room.

The water is heated with three Wesix water heaters interconnected with a garbage incinerator to a 500-gal. storage tank. A central electric refrigeration plant supplies refrigeration for all purposes. From this central plant brine is pumped to several refrigerator boxes and ice cream cabinets located in the kitchen and the grill. In addition to this, there is a large meat refrigeration box, and provision also is made for freezing some blocks of ice. The equipment was manufactured by the Brunswick-Kroeschell Ice Machine Company, and the boxes and cabinets were made by the Coast Refrigeration Company.

Modern electric equipment makes the large kitchen a model of cleanliness and service. The Westinghouse cooking equipment includes a 12-kw. broiler, two 24-kw. ranges, and a 3.5-kw. baking oven with Tycos temperature control. Provided opposite this equipment is a 14-kw. steam table manufactured by the Montague Range and Furnace Company, San Francisco.

Coffee for the guests of the Orinda Country Club is cooked on these electric urns. An electric warming oven immediately below the urns keeps the cups and saucers warm at all times.

Three large T. J. Tupper Company coffee urns, totaling 4 kw., equipped with a warming oven, supply an adequate quantity of this beverage for the club. A Surgex dishwasher, a Hobart dough mixer, and a 5.5-kw. Toastmaster complete the electric equipment in the kitchen. The kitchen contains two large refrigerator boxes and an ice cream cabinet, while the meat refrigerator adjoins it.

Electrical equipment in the men's grill includes griddle, hotplates, waffle iron, steam table, warming ovens, toaster, drink mixer, orange crusher, refrigerator box and ice cream cabinet.

All electrical equipment is on one master meter in order that advantage may be taken of the lowest possible electric rate. In order to do this it was necessary to install an 800-amp. 230-volt main switch.

Hamilton Murdock, Oakland, was the architect. The electric wiring was installed by the Scott-Buttner Electric Company of that city.

National Handbook for Wiremen Serves Practical Man

The theory and practice of electrical construction have been so modified and improved in the last few years that it is incumbent upon the electrical man to provide himself with the most complete and approved data if he would make a safe and acceptable installation. This material has been collected by Rollin Smith of Los Angeles and published as the National Handbook for Wiremen. The price of the book is $3.

The book is based on: The National Electrical Safety Code of the Bureau of Standards; The National Electrical Code of the National Board of Fire Underwriters; The Standards of the Underwriters' Laboratories; and the Electrical Safety Orders of the Industrial Accident Commission of California.

The publication is dedicated to the California Association of Electrical Inspectors as a contribution to its work in standardizing methods of electrical construction and in adding to the knowledge of electrical men.

An advisory council for the publication was composed of the following men:

H. N. Beecher, chief electrical inspector, Los Angeles Department of Electricity; F. A. Short, electrical engineer, Safety Electric Products Company, Inc.; J. H. Pengilly, electrical engineer, Brown & Pengilly, Inc.; R. H. Cates, power engineer, Southern California Edison Company; Otto Weimer, electrical engineer, Los Angeles Department of Electricity; C. W. Mitchell, electrical engineer, Board of Fire Underwriters of the Pacific; R. J. Larrabee, assistant electrical engineer, Underwriters' Laboratories; G. E. Kimball, electrical engineer, Industrial Accident Commission of the State of California; George W. Stirton, electrical engineer; William A. Spalding, retired editor; James H. Howard, electrical engineer; W. F. Alston, architectural engineer; Joseph H. Coburn, electrical engineer, and Dr. H. Wellington Taylor, illuminating engineer.

NEWS OF THE INDUSTRY

Water and Power Act to Reappear on California Ballot

Definite assurance that the Water and Power Act, without change in form or wording, will reappear on the ballot at the November biennial election this year, was given recently by Franklin Hichborn, of the California State Water and Power League. The Water and Power Act initiative was then in the hands of the attorney general's office for titling.

Mr. Hichborn gave the assurance that the only changes in the present Water and Power Act over that of previous years might be in the numbering of the measure upon the ballot.

First submitted to the voters in 1922, the Water and Power Act, which proposes the issuance of $500,000,000 of bonds for the development of water and power resources by the state, was turned down by a majority of more than 353,000 votes. Resubmitted in identically the same form in 1924, the measure again was defeated, the majority being over 432,000 votes. It now is proposed to bring the twice defeated initiative bill before the voters again in identically the same form in November.

During the past two campaigns the chief sponsor of the measure was reported to be Rudolph Spreckels, and it is understood that he will give the measure its chief support again.

Full text of the Water and Power Act was published in the Journal of Electricity Sept. 1, 1924, p. 177. With the exception of title to the act, which may be changed in the 1926 edition of it, the assurance given was that the wording of the present initiative proposal would be identical with that of 1924.

Decision Authorizes East Bay District as "Municipality"

Although applications for the development of power in connection with its Mokelumne project have been withheld temporarily, the East Bay municipal Utilities District, comprising the communities of the East Bay region of San Francisco Bay, was given a decision by the Division of Water Rights of the California Department of Public Works recently that establishes the district as a "municipality" within the meaning of the Water Commission Act.

The Division of Water Rghts ruled that the application of the district was an application by a municipality within the meaning of the term "municipality" as used in Section 20 of the Water Commission Act and that the Act contemplates a preferred priority for an application by a municipality for its general municipal uses as well as for only domestic purposes of its inhabitants, and consequently that the application of the district was entitled to a priority over the pending applications of J. W. Preston, Jr., Stephen E. Kieffer and all other pending non-municipal applications on the Mokelumne River. Recommedations for final action were forwarded to the Federal Power Commission.

On May 1 J. W. Preston, Jr., filed suit in the superior court at Jackson, Amador County, against the department of public works of the State of California, division of water rights, W. F. McClure, director of public works; Edward Hyatt, Jr., chief of the division of water rights; and the East Bay Municipal Utilities District. The suit seeks to have the court reverse or modify the action of the defendants, other than the East Bay Municipal Utilities District, by either denying a permit to the district or issuing the permit subject and in subordination to the prior right of the plaintiff under the prior applications.

Utah Town Plans New Street-Lighting Installation.—The town of Vernal, Utah, has approved plans for the installation of a new street lighting system, to be installed early this summer.

Linemen tying back lines within 100 ft. of river of burning oil at recent San Luis Obispo oil fire

Re-argument of Herminghaus Case Set for July 26

Arguments in the appeal before the Supreme Court of California against the injunction handed down by the Fresno County superior court in the Herminghaus suit against the Southern California Edison Company will be reopened July 26, 1926, according to announcement from the court. The decision of the lower court enjoins the Edison company from storing water in Huntington Lake on its Big Creek project except that which is produced by the run-off in the Huntington Lake basin. (Journal of Electricity, March 1, 1925, p. 185.)

The case was argued before the State Supreme court in January of this year, and briefs were filed by power and irrigation interests as well as by the Federal Power Commission, the state division of engineering and irrigation and the state division of water rights. (Journal of Electricity, Jan. 15, 1926, p. 66.) Decision by the court was held up once until additional briefs were filed, and the present announcement that the case will be reopened for further argument will delay the final decision until late summer.

Linemen Work in Danger Zone at $15,000,000 Oil Tank Fire

Linemen employed by the Midland Counties Public Service Corporation played a romantic role when a river of blazing oil from the Union Oil Company's big storage tank farm near San Luis Obispo, Calif., ignited by lightning on April 7, ran toward the sea, endangering the power company's pole line. The men were forced to do their work, that of tying back the lines, within 100 feet of the flowing inferno, which followed a creek bed down a narrow valley. The fire, burning in the huge reservoirs and tanks for nearly a week, consumed 6,000,000 barrels of oil, causing a loss to the oil company and insurance companies of approximately $15,000,000.

Northwestern Electric Company Starts New Indoor Substation.—A 3,000-kw., automatic indoor substation has been commenced by the Northwestern Electric Company, Portland, at East 32d and Weidler Streets. This location is in the midst of one of the residential districts of the city, and the building is designed architecturally to harmonize with its surroundings. It will be faced with red brick and trimmed in gray stone, and the ground around it will be landscaped elaborately. This marks a change in policy as to substations of this class, former ones having been of the outdoor type. The design allows for a possible doubling of the capacity in the future.

Irrigation-Reclamation Committee Reports Favorably on Swing-Johnson Bill

Washington Correspondence

A favorable report on the Swing-Johnson Bill has been made to the Senate by the Committee on Irrigation and Reclamation.

The bill in the form in which it now is pending on the Senate calendar provides for a dam at Boulder or Black Canyon on the lower Colorado River; for the construction of an All-American Canal for the delivery of water to the Imperial Valley, and for a power plant.

Secretary Mellon's suggestions for the financing of the project are embodied in the bill. A Boulder Canyon fund is set up in the treasury. The Secretary of the Treasury is authorized to advance to the fund up to $125,000,000, from which interest payments are to be deducted. The interest during the construction period will amount to nearly $21,000,000.

The Secretary of the Interior is authorized to make contracts for the sale of power at the switchboard and for water for irrigation and domestic uses. The dam and works are to remain the property of the government, even after they are paid for by the beneficiaries.

Contracts for power are limited to fifty years. Renewals are to be made as provided in the Water Power Act. Conflicting applications also are to be handled along the lines of the Water Power Act. Small agencies are to be permitted to share in the use of transmission lines. The secretary, in his discretion, may lease the privilege of using the water discharged at the dam.

An extended minority report was filed by Senator Ashurst of Arizona, who declares the purpose of the bill is to coerce that state.

He further declares that a high dam at Boulder will prevent the development of the maximum resources of the stream and declares it to be abysmal folly to use 200,000 firm horsepower in the eternal task of raising water 1,730 ft. for use in southern California, when adequate supplies can be obtained at no greater cost by diverting the water at Bridge Canyon. That dam with another at Glen Canyon, he claims, would allow the maximum use of the waters of the river.

President Coolidge personally has given assurance of his support of the bill to Representative Smith, chairman of the House Committee on Irrigation and Reclamation, and to Representatives Swing and Sinnott.

Ratification of Colorado River Compact Urged by Secretary Work

Speaking before the Los Angeles Chamber of Commerce at a luncheon April 26, Hubert Work, Secretary of the Interior, urged the speedy ratification of the pending Colorado River compact.

"It will make for a just division of the Colorado River waters between the upper and lower states and bring to an end a threatened and costly interstate rivalry," he declared.

"The necessity for an early settlement of the respective rights of the different states and two nations in this river and in the carrying out of the proposed development on the lower portion of the stream, is vital," Secretary Work continued. "The potential benefits to be derived from this development are of great national interest and importance. It is, therefore, of the greatest importance that agreed upon facts in connection with this Colorado River development be set properly before Congress, as a national undertaking, so that suspicion may be avoided that its purpose is for personal promotion or local development only.

"It is my belief that as soon as the Boulder Dam legislation has been approved by Congress the applications for private power development should have immediate consideration. There does not seem to be any danger that the power market will be over-supplied. On the contrary, cheap power will help to open up new mines, promote the building of new railroads and multiply industries.

"The proposed project, in its engineering phases, is the greatest work of its kind in the world," he said. "Its magnitude will challenge the talent of the country's ablest engineers. As designed, it will contain 3,375,000 cu.yd. of concrete, or three times that of the Assouan Dam of Egypt, which is the greatest masonry dam ever built.

"If an organized corporation, competent and willing to develop this project in its several ramifications, will come forward and submit a contract to build these structures and place their operation under such control of the government as will protect the many and diversified interests involved, the Secretary of the Interior will recommend to Congress that such proposition be sympathetically entertained."

Referring to Arizona's failure to ratify the Colorado compact, Secretary Work said:

"The Colorado River compact is being resisted by a state that could profit by this comprehensive development. Maneuvering for individual or corporate advantage is being resorted to by those speculating in hope, but it is confusing the main issue."

Puget Sound Company to Erect Building.—The Puget Sound Power & Light Company, Seattle, has purchased nine lots at Eighth Avenue North, between Roy and Aloha Streets, comprising 62,640 sq.ft., for a consideration of $80,000. On this property the company plans to erect a building to house quarters for linemen, warehouse space for materials, rest rooms, assembly room and large garage. The structure will be one-story, reinforced concrete, 116x315 ft.

Power Project to Be Commenced at Lewiston, Idaho

Contract for construction of a dam, forebay dyke and power house at Lewiston, Idaho, a power project which is a part of a joint timber development plan in which the Weyerhaeuser interests and the Northern Pacific and Union Pacific Railways are identified, has been awarded to Winston Bros. of Minneapolis. The entire project will cost more than $13,000,000, of which $2,000,000 will be expended on the power development. The contractors are expected to start work in May and to have the dam completed by May 1, 1927.

The railroads are engaged in building a 41-mile branch line and the Weyernaeuser company is building a lumber mill adjoining the power site. The timber company is under contract to furnish 200,000,000 ft. of timber annually to the railroads when the project is completed.

Black Eagle Falls Plant Started by Montana Power Company

Work has been started by the Montana Power Company upon a new 25,000-hp. hydroelectric generating station at Black Eagle Falls on the Missouri River, near Great Falls, Mont. The new station will replace an obsolete power plant built in 1890 to supply the Boston & Montana smelter. The estimated cost of the new installation is $1,000,000.

The plant will utilize a drop in the river at this point of 25 ft. through three propeller-type vertical turbines. These turbines will be the largest of this type to be installed up to the present time. In reconstructing the present timber crib dam, provisions will be made for the passing of 100,000 sec.-ft. of flood waters, the maximum to be recorded at this point. Adequate water is assured for the plant on account of other hydro developments higher up on the Missouri and Madison Rivers.

Present plans call for the completion of the development in the summer of 1927.

Five Are Killed as Bucks Creek Tunnel Caves In

Working at the face of the heading of the tunnel being driven to connect the waters of Bucks Creek with those of Grizzly Creek on the Feather River Power Company's Bucks Creek hydroelectric project, six men were imprisoned when tunnel timbering was crushed and 42 ft. of the tunnel adjacent to the heading collapsed April 17.

Further slipping of heavy ground hampered the work of rescue crews, working at top speed to reach the men. The crews worked in short relays and with every means at their command sought to remove the imprisoned men alive. They succeeded in reaching and bringing out alive one of the men, sixty-eight hours after the cave-in. A few hours later the bodies of the other five were found.

The tunnel is being driven by crews under the subcontractors, Dardier & Richardson, San Francisco. It is 7 ft. wide and 8 ft. high, and had been driven to a length of 136 ft. when the collapse occurred.

Valuation of Colorado Utility's Property Well Under Way

Valuation of the property of the Public Service Company of Colorado in Denver by representatives of the city under the direction of H. B. Dwight, engineer of the Colorado Public Utilities Commission, is actively under way. Inasmuch as the present franchise expires May 15, city and company officials agree that it is absolutely impossible to submit the measure to a vote of the people before that date and consequently an ordinance now is being prepared in which present rates and relationships are to be continued indefinitely and until the new franchise is denied or approved.

In the meantime an unfortunate situation has been injected into the franchise matter, it is reported, through the action of a small group of voters whereby a petition establishing lower rates for both gas and electric service has been filed in legal fashion, and as a result of Denver's home rule charter provision this measure also must be submitted to a vote of the people at either a special or general election. Rates required by the petition represent approximately a fifty per cent reduction.

Aberdeen Rejects Stevens & Koon Report on Wynooche

Refusing to accept the findings of Stevens & Koon, consulting engineers, Portland, who were employed by the city of Aberdeen, Wash., to make an estimate of its water and power project on the Wynooche River, the city council of Aberdeen has approved the employment of W. J. Roberts, consulting engineer, Tacoma, to make a new report of the project. The council further agreed to delay for two weeks action on the ordinance proposing to submit to the voters a bond issue in the amount of $2,000,000 to build the municipal power development on the Wynooche. In the meantime it appointed a committee, headed by S. C. Watkins, superintendent of water department, to take steps to acquire a dam site and impounding basin on the Wynooche for the commencement of the municipal water project for which $700,000 in bonds have been voted.

The report of Stevens & Koon is one of a number of reports that have been made on the Wynooche project, and, incidentally, estimates the cost higher than any of its predecessors. The cost of the plant at the end of nine years, after which it is estimated the operating revenue will begin to produce a surplus instead of a deficit, is figured to be $5,551,000. This allows for nearly $1,000,000 over the actual cost to carry the plant through this development period.

The actual construction cost was placed at $4,797,000, of which $3,592,000 would be required for early construction on the plan recommended. This estimate includes dam, tunnel, 24,000-hp. power plant with a daily load factor of 48 per cent, 26-mile transmission line to Aberdeen, substation and 40 miles of distribution line in the city. It includes also a tie transmission line to the Cushman plant of the city of Tacoma, a distance of 23 miles, and allows $100 per acre for clearing 2,600 acres of the storage basin to make the water fit for the city water supply source.

Calling attention to the fact that the city would have to develop its power business in competition with a private company and that this development necessarily would be slow, the report recommends that the city defer construction of the Wynooche project as follows: it is suggested that the start should be made in a small way and continued until a power load has been developed; deferring the construction of the large hydroelectric plant until there is load enough in sight to warrant its development."

C.R.E.A. Will Hold Meeting in Santa Ana June 7

A statewide meeting of the California Committee on the Relation of Electricity to Agriculture will be held in the Ebell Clubhouse, Santa Ana, Calif., June 7, 1926, the day preceding the Pacific Coast Electrical Association Convention in Los Angeles. A noteworthy program has been arranged for the meeting which will interest all of those connected with the application of electricity to agriculture.

J. J. Duell of the Farm Bureau Federation will preside. Included among the speakers will be Roy Bishop, president Orange County Farm Bureau; L. J. Fletcher, chairman California Committee on the Relation of Electricity to Agriculture; W. S. Rosencrans, vice-president, California Farm Bureau Federation; Ezra Decoto, member of the State Railroad Commission; S. S. Knight, legisiative representative, Farmers' Grange and Farmers' Union; A. Emory Wishon, vice-president and general manager, San Joaquin Light & Power Corporation.

All of those who are interested in this vital subject are invited to attend as no formal invitations will be issued.

Commission Extends Irrigation Rate Period in Utah

An order extending the period of time during which the Utah Power & Light Company's existing rates for irrigation pumping shall be effective has been issued by the Public Utilities Commission of Utah. The order was granted on petition of the Utah Lake Distributing Company and a stipulation between the power company and the water company in which the power company waived formalities.

The petition set forth the fact that in 1922 an order was granted because of the existence of an agricultural emergency, and declared that the same emeregncy continues to exist. The order of 1922 gave to the then existing irrigation customers of the power company power at the same rates effective prior to the advance granted by the commission in the power rate case.

Large Power Plant Planned for Nasel River, Wash.

Application for the appropriation of 670 sec.-ft. of water from the north branch of the Nasel River, flowing from Pacific County into the Pacific Ocean in the western part of Washington, has been made by Henry L. Gray of Seattle to the state supervisor of hydraulics at Olympia. The water will be used in the development of 10,000 hp., and plans include a dam 110 ft. high to impound 20,000 acre-ft. of water which will be conducted to the power house through a tunnel and pipe line 1,675 ft. long. The estimated cost of the project is set at $1,500,000.

Another application made recently is that of the Royal Development Company of Leavenworth, Wash., which seeks an appropriation of 30 sec.-ft. of water from Phelps Creek, a tributary of the Chiwawa River. The power to be developed, 1,080 hp., is to be used entirely for mining purposes. The power house already has been built and the cost of completing the project is estimated at $40,000.

Edward Fitzpatrick of Ovington, Clallam County, Wash., has applied for a 30-sec.-ft. appropriation from Sapoel Creek to generate approximately 3,600 hp. under a 1,200-ft. head. A timbered dam, 25 ft. high, is to be erected, and the cost of the project will be approximately $50,000.

Another project in the same district, the extreme northwestern part of Washington, is that contemplated by W. E. Theodore of Seattle, who has asked for 20 sec.-ft. of water from Eagle Creek for the generation of 4,600 hp. under a 2,300-ft. head. A dam similar to that of the foregoing development is planned, and the estimated cost of the project will amount to $45,000. Both projects are to be completed within three years.

Washington Utility Sells 9,036 Shares of Stock in 8 Days

In reopening its customer-ownership campaign at Spokane, Wash., The Washington Water Power Company met with unusual success in its efforts to place 15,000 shares of 6½ per cent cumulative preferred stock among its customers. In the first eight days of the new campaign a total of 741 customers and employees subscribed for 9,036 shares of stock, par value $100, and made cash payments totaling $500,669 against the aggregate par value of $903,600. A limit of 25 shares to a customer was established.

The stock was sold through the company's department of public relations, of which W. H. Ude is director.

Extensive Improvements Planned in Yakima Valley, Wash., by Power Company.—The Pacific Power & Light Company of Yakima, Wash., plans extensive improvements in the Yakima Valley during the year. At the Naches plant a 400-ft. penstock is under construction; in Toppenish, a new substation is to be built with capacity of three times the present one, and is to be equipped with six 500-kw. transformers. The company will build immediately 2½ miles of line to supply the Harrah and Bench communities.

Make Reservations Promptly for Northwestern Convention

Plans for the annual convention of the Northwest Electric Light and Power Association, Spokane, Wash., June 14-17, are going forward but at the time of going to press are not advanced sufficiently so that a definite statement can be made as to the program. R. B. McElroy, chairman of the hotel reservation committee, has issued a request that reservations for rooms at the Davenport Hotel be made through him as early as possible. On account of the fact that other conventions are coming to Spokane at about the same time, accommodations may be available only if reserved well in advance.

Valuation Decision Reversed by Washington Court

Having the effect of reversing the order of the Washington Department of Public Works by which the rate base of the Pacific Power & Light Company, Portland, was reduced (Journal of Electricity, Jan. 15, 1926, p. 69), Judge John M. Wilson, of the Superior Court of Washington for Thurston County, has handed down a memorandum opinion declaring that the department could not make certain changes in the rate base which it had attempted to make. Conforming to this opinion, formal judgment will be entered remanding the case to the department for further action.

The case had been brought by the company following the department's order of Dec. 31, 1925, which reduced the value of the company's Yakima-Walla Walla, Wash., power system by $1,137,244, basing such order on the evidence gathered prior to and at the hearing at Walla Walla in August, 1925. The largest item in the reduction was for certain generating and transmission property in Oregon, which it was contended had been included erroneously in the Washington rate base fixed by a previous order; and the cities of Yakima and Walla Walla and others bringing the original complaint had alleged "palpable error" in this connection. In the present case the company's claim alleged that no such error existed and that, according to the statute, the former order was conclusive except as to subsequent changes by additions and retirements. In the opinion handed down the court agreed with the company's contention as to the Oregon properties, stating that the original valuation order shauld stand conclusive until changed by a revaluation.

Following the opinion, H. C. Brodie, assistant attorney general, announced that the case would be appealed to the supreme court of the state.

Contract Let for Clearing Power-Line Right-of-Way.—The Northwestern Power Company recently has awarded contract for clearing 99 acres of right-of-way for a prosposed power line along the banks of the Elwha River, near Port Angeles, Wash. The right-of-way will be 8 miles long.

Pacific Coast Electrical Association

Code of Standards Adopted by Advertising-Publicity Section

Approval of the organization and code of practice as set forth in its proposed "Book of Standards" was given the standards committee of the Advertising-Publicity Section, Pacific Coast Electrical Association, at the meeting of the Section in San Francisco, April 23. Dan L. Scott, Los Angeles Gas & Electric Corporation, chairman, presided.

The standards committee's report consisted of the proposed form of the Book of Standards, setting forth the scope, purposes and the administrative functions of the Section and formulating a code of procedure in advertising and publicity practice conforming with the "truth in advertising" movement of the Advertising Clubs of the World. Resolutions condemning the one-time special edition or special advertising page also were incorporated in it.

The report, as read by W. A. Cyr, Journal of Electricity, in the absence of Ben S. Allen, Key System Transit Company, chairman of the standards committee, was approved with minor modifications. The standards committee then was instructed to issue 100 copies of the book in loose-leaf form for the guidance of members. The content of the Book of Standards was ordered published as the Section's paper for the annual proceedings of the association.

The advertising display, to be shown at the convention in Los Angeles, was discussed, and suggestion made and accepted that a small display of general classes of advertising, made up from the best specimens furnished by all companies, be arranged for. Papers or topics to be discussed at the open meetings of the Section at the convention were decided upon, and the meeting adjourned to a buffet luncheon.

Tentative Program of P.C.E.A. Convention Is Given

According to reports, all major arrangements pertaining to the annual P.C.E.A. convention practically are completed. But few details remain yet to be finally settled to round out the plans for what promises to be one of the best conventions held so far.

The following program is presented as a tentative arrangement of the business and social meetings and indicates the thoroughness with which the program committee has solved its problem. It may be noted that sessions are so planned that all of the section delegates may attend all of the general sessions, thereby broadening their scope of contact with and understanding of the industry, and also attend the business sessions of their particular section.

Tentative Program

Monday, June 7.
Afternoon—Registration.
Evening—Dance.
Tuesday, June 8.
8:00 to 10:00 a.m.—Registration.
10:00 to 12:00 a.m.—Address of welcome. Reports. Announcements of committee chairmen.
12:15 p.m.—Luncheon.
2:00 p.m.—Parallel sessions of sections.
9:00 p.m.—Reception to president. Formal dancing.
Wednesday, June 9.
9:00 to 12:00 a.m.—Geenral session of all sections.
2:00 p.m.—Parallel sessions of sections.
9:00 to 12:00 p.m.—Informal dancing.
Thursday, June 10.
9:00 to 12:00 a.m.—Executive committee meeting. General session.
Afternoon—Sports and ladies' entertainment.
9:00 to 12:00 p.m.—Informal dancing.
Friday, June 11.
9:00 to 12:00 a.m.—General session.
2:00 p.m.—General business conference.
7:00 p.m.—Annual banquet.

Biltmore Hotel, Los Angeles, convention headquarters.

News of the Electragists

Rocky Mountain Electrical Co-operative League Holds Annual Convention

Nearly two hundred members of the electrical industry, representing its various branches in Salt Lake City and adjacent territory, were in attendance at the fifth annual convention of the Rocky Mountain Electrical Co-operative League held at the Newhouse Hotel in Salt Lake City on April 7.

The afternoon session opened at 2:30 with Vice-President B. E. Rowley, manager of the Edison Electric Appliance Company's Salt Lake City branch, presiding.

T. T. Burton, city commissioner of Salt Lake City, spoke on the subject "Electrical Wiring as it Affects Public Safety." Mr. Burton, who is in charge of the city's public safety department, told of some of the activities of his department in recent surveys of electric wiring conditions in the business section, and pointed out a number of instances where improvement in conditions could be brought about. He urged the electrical people and the league as an organization to assist the public officials in promoting the utmost safety possible in wiring conditions.

In the discussion which followed, H. M. Ferguson, manager of the Utah Power & Light Company's Salt Lake division; Charles J. Reading, of the city's electrical department; Walter S. Knight, fire chief; and W. A. Moser, manager of the Salt Lake City office of the Westinghouse Electric & Manufacturing Company, spoke, commenting on various phases of the problem.

F. D. Winegar, city electrical inspector, followed with a brief discussion of the question of safety in electrical wiring, pointing out the fact that there is a vast difference of opinion as to what constitutes hazards.

George R. Randall, president of the league, suggested that it is largely up to the electrical people themselves to determine the difference between good and bad jobs. H recommended that the members of the electrical industry now should adopt a more aggressive policy in assisting to improve conditions, and urged that whenever an electrical contractor's license is granted the recipient of such license should be required to show certain qualifications in his line of work.

The next speaker was George R. Randall, president of the Rocky Mountain Electrical Co-operative League. His subject was "League Activities—Past and Future." He emphasized the good work being accomplished by the Lighting Service Bureau, which he stated was clearly shown by marked increases in kilowatt-hour consumption as indicated by the records of the central station among its commercial lighting customers. A considerable portion of this increase, he said, undoubtedly was due to the activities of the Lighting Service Bureau. He called attention to the fact that of 330 lighting layout jobs planned by the bureau, 245, or 80 per cent, had been closed, with the result that all branches of the electrical industry received some benefit therefrom.

S. W. Bishop, executive manager of the Electrical League of Colorado, was the principal speaker of the evening. His subject was "Outlets for Outlets." Mr. Bishop stated that electrical leagues throughout the country are performing a remarkable work, providing one of the big solutions for the problems confronting the electrical industry today. He presented the following outline of activities in league work that have had a far-reaching effect in other parts of the country:

Serving the public as a bureau of electrical information.

The maintenance of a staff to work directly with architects, builders, owners, and others in advising on electrical installations in all types of buildings.

Working toward the continual improvement and enforcement of electric wiring rules.

Explaining, demonstrating and emphasizing the necessity and value of proper lighting.

Encouragement and co-ordination of electrical exhibits.

Establishment of electrical homes in the most advantageous places.

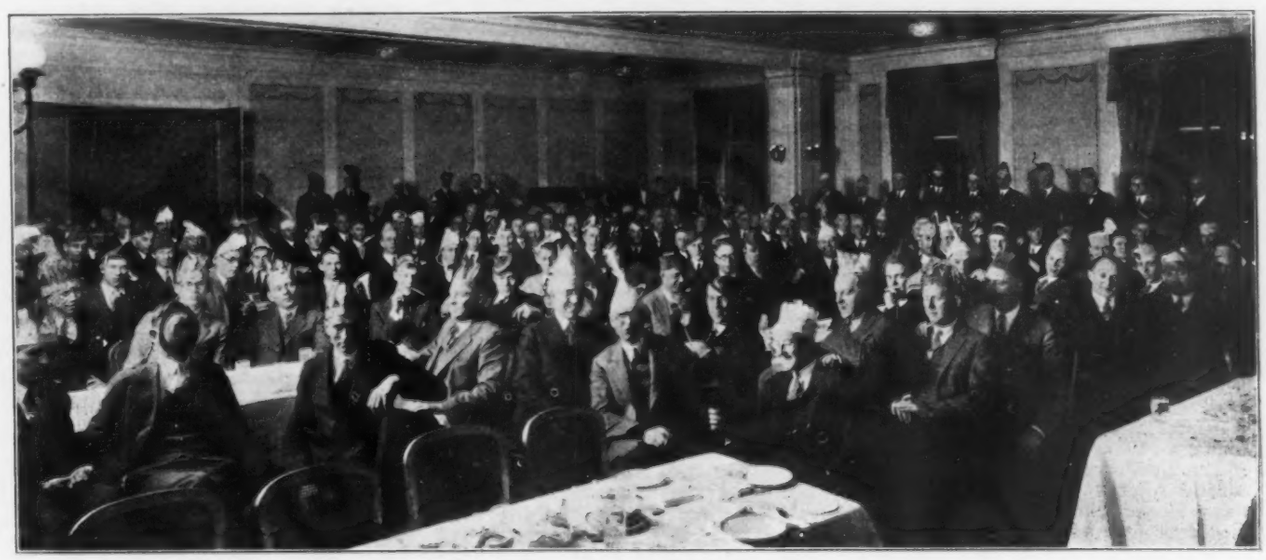
Development of teamwork throughout the industry by get-together meetings and other social activities.

The establishment of a consciousness in the mind of every electrical man in the community that he cannot be an ardent electrical advocate until he himself practices the precepts of the industry.

The education of the consumer to the value of the league and the whole-hearted willingness and ability of the industry which it represents.

In emphasizing the importance of adequacy of convenience outlets, Mr. Bishop quoted the following statement by O. H. Caldwell, editor of Electrical Merchandising:

Electrical articles are the only ones which cannot be taken home and put to use by the purchaser—when, where and as he pleases. What "good roads" mean to automobile sales,



Banquet held during the fifth annual convention of the Rocky Mountain Electrical Co-operative League in Salt Lake City.

adequate outlets mean to appliance sales. Appliance men's own interests lie, therefore, in getting more wiring per home in order to sell more appliances per home.

Edward H. Eardley, manager of the Eardley Electric Company of Salt Lake City, next spoke on the subject, "The Electrical Contractor's Problems." Mr. Eardley's paper included a discussion of the important position which the contractor holds in promoting the best interests of the electrical industry. Mr. Eardley urged the contractor to study his business. "When a man ceases to be a student," he said, "he ceases to be a teacher, and when he ceases to be a teacher he is not capable of knowing what is right with respect to his business, and then he ceases to be a business man."

Nearly two hundred guests assembled at the banquet in the evening in the ballroom of the Newhouse Hotel. George R. Randall presided, introducing J. A. Kahn, president of the Capital Electric Company of Salt Lake City, as toastmaster.

P. M. Parry, commercial manager of the Utah Power & Light Company, spoke briefly concerning the place which the central station fills in the league's activities. A. C. Cornell, manager of the Graybar Electric Company's Denver branch, and president of the Electrical League of Colorado, presented an interesting paper on the subject, "The Jobber's Viewpoint."

Mr. Bishop complimented the electrical people of the Intermountain territory served by the Utah Power & Light Company in regard to the world's record which this section enjoys in the annual kilowatt-hour consumption per capita.

In regard to methods of operation of leagues and specific activities, Mr. Bishop suggested the advisability of not giving too much pressure to one particular activity but getting the general idea over to the public by plenty of publicity; adequate electric wiring standards as reflected by electrical inspection codes; encouraging the giving of the best for the money so that the greatest service and economy will be had by the customer ten years from now; uniform electrical ordinances; considering the national code as a minimum for operation in any city; maximum of service to be had from cost of wiring. He pointed out also that the development of ordinances, codes, etc., is up to the people of the electrical industry.

The Red Seal plan was explained thoroughly by the speaker, and he recommended that it be included in the league's program. He also recommended seasonal campaigns such as Christmas window trimming, co-operative newspaper advertising during the Christmas season, Christmas Cheer week, and June Bride Week.

Mr. Bishop's address concluded the program of the most successful convention in the league's history.

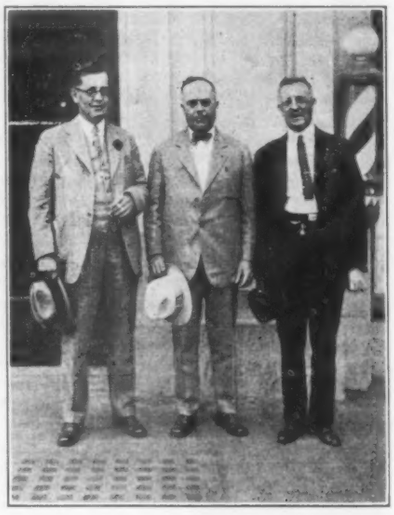
Inspectors of Northwest to Meet in January, 1927.—The annual meeting of the Northwest Association of Electrical Inspectors will be held in Longview, Wash., Jan. 17-18, 1927. W. P. Weathers, vice-president of the association, is chairman of the convention committee.

Pasadena Electragists Sponsor Red Seal Meeting

A Red Seal meeting was held in Pasadena Friday evening, April 23, under the auspices of the Pasadena Electragists and the Southern California Edison Company. The Red Seal playlet, "Listen, George," written by Richard E. Smith of the Southern California Edison Company, was presented. The parts of George and Mabel were taken by Mr. and Mrs. Cyril Briggs, professionals, supported by H. W. Barnes, Pasadena electragist, in the part of Mr. Stewart, the electragist, and Miss Adele Blauvelt as Aunt Caroline. The play was ably presented and made a very good impression.

Short addresses were made by H. W. Gates of the Pasadena Realty Board; W. L. Frost, Southern California Edison Company; B. S. DeLanty, manager of the Pasadena municipal lighting plant; W. F. Brainerd of the California Electrical Bureau; and Edgar W. Maybury of Marston, Van Pelt & Maybury, architects of Pasadena. Mr. Maybury stated frankly that he had hesitated to speak at this meeting because he was not sure that he could indorse the Red Seal plan. However, after it had been thoroughly explained to him he stated that he was heartily in favor of the plan and would specify Red Seal in future residence jobs.

Seventy-five builders, architects and electrical men were present. While the Red Seal plan is just getting under way in Pasadena four houses already are being wired under it.



The three graces at the convention of the California Association of Electrical Inspectors at San Diego, March 22-24. All of them were from THE VALLEY. Which valley? Ask Mr. Stitt. From left to right—H. W. Stitt, Fresno; Frank Morrell, Stockton; and Carl W. Beaton, Sacramento.

George D. F. Smith of the **Smith Electric Company** has announced its removal to 975 Howard Street, San Francisco. The new quarters provide double the floor space, and the company expects to expand its motor and fixture departments. The former location was at 50 Natoma Street.

Red Seal Plan Endorsed by Marin County Realty Board

A joint meeting between the Electrical Development League and the Real Estate Board, both of Marin County, Calif., held at Hotel Rafael recently, resulted in the wholehearted endorsement of the Red Seal plan by the realty board. The well attended meeting was presided over by Mayor Bowman of San Rafael, who is also president of the Real Estate Board.

C. Felix Butte, vice-president of the California Electragists and chairman of its Northern Division, and Victor Hartley, executive secretary California Electrical Bureau, addressed the meeting.

Calling for comments from the assemblage, Mayor Bowman brought forth many expressions of approval for the plan. One speaker, a member of the realty board, provided a surprise by an eulogy of his modern electric home, declaring that if he could not get another electric range he would not take a thousand dollars for the one he has. He also commented on the economy of operating his all-electric home, his remarks having the effect of crystallizing the sentiment of the meeting into a complete endorsement of the Red Seal plan.

James W. O'Brien and **Earle C. Richardson** have purchased the business of the **Walker Electric Company** at Salt Lake City. The former was for many years connected with the Utah Power & Light Company as superintendent of lines and service at Ogden, and later as division manager at Park City, Utah. Mr. Richardson was associated with the **Richardson-Hunt Company** at Ogden as manager of that concern. Both of these members of the new firm are equipped with a thorough knowledge of the electrical retailing business.

Los Angeles Association Elects Officers.—The following have been elected officers of the Electrical Contractors and Dealers Association of Los Angeles: president—B. R. Hensel; first-vice-president—C. S. Hill; second vice-president—D. D. McFarlane, Newbery Electric Corporation; third vice-president—R. L. Booth, English Electric Company; secretary-treasurer—J. Arthur Curtis. Helen Mikesell will continue as executive secretary of the association.

Two Districts of California Electragists Consolidate.—The Burbank and Glendale districts of the California Electragists, Southern Division, have consolidated. In this way a larger territory is served by the one organization and a larger attendance is secured at each meeting.

Ball Electric Shop has been opened at 143 Davis Street, Santa Paula, Calif., by **C. M. Ball.** Mr. Ball formerly was with the Southern California Edison Company and also the Public Service Company of Colorado.

The Eardley Electric Company has moved to 364 South State Street, Salt Lake City. The previous place of business was at 54 Exchange Place.

Meetings

Dr. Millikan Is Guest of Utah Engineering Council

Dr. Robert A. Millikan, director of the Norman Bridge Laboratory of Physics and executive head of the California Institute of Technology, Pasadena, Calif., was the principal speaker at the annual dinner of the Engineering Council of Utah held at the Hotel Utah in Salt Lake City March 22. Dr. Millikan discussed the electronic theory of the constitution of matter.

C. B. Hawley, general manager of the Inter-Mountain Electric Company, was toastmaster at the dinner and made the introductory speech, in which he outlined the achievements of Dr. Millikan.

Dr. Millikan, accompanied by Mrs. Millikan, left immediately after the dinner for the East where he was scheduled to attend a meeting called by Herbert Hoover, Secretary of Commerce, to consider the establishment of a fund of $20,0000,000 for the advancement of pure science in the United States.

Chapter Illuminating Engineers Formed for Puget Sound

Organized late in April, the Puget Sound chapter of the Illuminating Engineering Society held its first programmed meeting in Seattle, May 11, with an illustrated lecture on color. F. A. Osborn, head of the department of physics, University of Washington, Seattle, is chairman of the new chapter.

For the chapter's June meeting it was announced that a talk on "The A, B, C's of Illumination" would be presented.

Contra Costa League to Hold Annual May Party.—The Contra Costa County (Calif.) Electrical Development League has announced its annual May party for May 22, to be held at Livermore, Calif. Women folks of the members have been invited to the festivities, the program arranged being for their especial benefit. Invitations have been sent to the Oakland Electric Club and other Bay region electrical groups to take part in the party with the Contra Costa electrical men.

Explains Klydonograph.—T. P. Garrett, assistant general engineer of the Westinghouse Electric & Manufacturing Company, San Francisco division, explained the operation and uses of the Klydonograph in determining the nature and cause of transmission line surges at a meeting of the Oakland Electric Club, May 3. The lecture was illustrated with lantern slides.

N.E.L.A. Serial Reports.—A 4-page serial report of the meter committee on Periodic Test Schedule for Watthour Meters and Method for Recording Results. Price to members 10 cents. A 20-page serial report of the prime movers committee on Coal and Ash Handling. Price to members 25 cents.

Railway Team Wins Los Angeles Electric Club Tournament

Finishing the season with an accumulation of 73 points, the bowling team of the Pacific Electric Railway won the championship in the Los Angeles Electric Club Bowling League. In winning the championship it also won a cash prize of $102.16.

The Southern California Edison Company finished second, Southern California Telephone Company third, and Los Angeles Department of Water and Power fourth. A total of twenty-four teams took part in the league race with the booby prize falling to the H. H. Walker and Western Light & Fixture Company fives, each scoring 26 points.

Five members of the Electric League will comprise a team which will represent the circuit in the coming Pacific Coast Bowling Congress tournament, which will start at San Diego on May 1. The lucky knights are R. D. McCubbins of the Pacific Electric Railway team, Jack Emerson of the Southern California Telephone Company team, M. A. Burch of the Los Angeles Department of Water and Power, C. Groschong of the Southern California Telephone Company and L. H. Covell of the Pacific Electric Railway. Joe Sines, secretary of the league, will escort the knights to the southern city.

COMING EVENTS

California Electragists, Northern Division—
Quarterly Meeting—Hotel Senator
Sacramento, Calif.
Friday, May 21, 1926

Electrical Supply Jobbers' Association—
Annual Convention—Hot Springs, Va.
May 31-June 4, 1926

Advisory Committee, California Electrical Bureau —
Jonathan Club, Los Angeles, Calif.
June 7, 1926.

Pacific Coast Electrical Association—
Annual Convention—Biltmore Hotel, Los Angeles
June 8-11, 1926

Associated Manufacturers of Electrical Supplies—
Annual Convention—Hot Springs, Va.
June 7-12, 1926

Northwest Electric Light and Power Association —
Annual Convention—Spokane, Wash.
June 14-17, 1926

American Society of Agricultural Engineers—
Annual Convention—Tahoe Tavern,
Lake Tahoe, Calif.
June 23-26, 1926

American Institute Electrical Engineers—
Pacific Coast Convention, Salt Lake City, Utah
Sept. 6-9, 1926

Puget Sound Company Entertains at Gyro Club Meeting in Everett, Wash.—The Puget Sound Power & Light Company recently furnished the evening's entertainment at the Gyro Club meeting in Everett, Wash., with George Barnes, local manager, in charge. Norwood Brockett, director of public relations, spoke on rates and regulations after briefly outlining the history of the power and light industry. Motion pictures of the new Baker River power project were shown.

Book Reviews

MAGNETS

By CHARLES P. UNDERHILL, consulting electrical engineer; 6 x 9; 468 pages; 467 figures. $4. McGraw-Hill Book Company, Inc., New York, N. Y.

To an engineer or a student seeking information on the broad subject of magnets, there is probably no text available which treats the subject in as thorough and an interesting manner as this book. According to the author, the object of the book "is to treat broadly the general principles of apparatus electromagnetically operated and controlled, but particularly to treat electromagnetic and permanent magnets in detail."

The introductory chapter covers the definitions of various classes of magnets, the materials, together with their properties, which enter into their structure, and the outstanding phenomena associated with them. Next is treated the various forms of magnets and the general pull characteristics of common forms of constant current magnets, together with methods of varying these characteristics. In a chapter devoted to time and polarity characteristics, the various methods of making electromagnets quick acting, sluggish, or reversible are treated. Then follows a chapter treating that very useful application of the electromagnet in the machine shop and foundry when magnetic chucks and lifting magnets are applied. After a description of switching control, protective apparatus, and miscellaneous electromagnetic devices, the various forms and characteristics of solenoids are treated. Considerable design data are given, and the operating features of commercial shunt-wound and series-wound solenoids are furnished in the form of compact tables. One of the most interesting chapters in the book, from the viewpoint of the student and designer, is that which treats of the logarithmic current-time and voltage-time characteristics of direct-current phenomena. Tables are presented for comparatively easy solution of problems which would require complicated mathematical treatment. Magnetic circuits and their phenomena cover several chapters, and after a short treatment of alternating current phenomena, a.c. solenoids and electromagnets are treated. The book closes with a chapter on permanent magnets. The widespread application of electrical magnets will be appreciated when it is remembered that generators, transformers and motors are merely electromagnets in some combination and the electrification of industry and the development of huge central station systems of today have been paralleled by the development of electromagnet devices that control the operation of various machines used in these very modern industries.

This statement points out very clearly the importance of the various forms of magnets. To the engineer who wishes to obtain more thorough information of the magnet in its various forms and various characteristics and to the student of electrical engineering, this book by Underhill should prove quite valuable.

E. R. S.

Personals

Howard W. Flye, since August, 1919, in the sales department of the San Francisco office of the Aluminum Company of America, has been appointed sales manager of that office. The territory under his jurisdiction comprises

HOWARD W. FLYE

California, Oregon, Washington, Idaho, Utah, Nevada and Arizona. Mr. Flye has been affiliated with the Aluminum Company since his graduation from Yale in 1913, when he entered the operating department. From there he went in 1915 to the Toronto works as superintendent, retaining that position until October, 1917, when he joined the United States Army for service in the World War. From that time until May, 1919, he served as captain in the ordnance department, acting as ballistic inspector in small arms ammunition and as inspector of ordnance in various arsenals and plants operating under United States Army contracts in the United States and Canada. After his discharge from the service he returned to the employ of the Aluminum Company, joining the sales force at Philadelphia, and a few months later was transferred to San Francisco. Mr. Flye is a native of Boston.

William Baurhyte, president, Las Angeles Gas & Electric Corporation, recently left to attend the N.E.L.A. convention at Atlantic City. **J. B. Black**, vice-president and general manager, Great Western Power Company, San Francisco, also is en route to the convention.

A. E. Wishon, vice-president and general manager, San Joaquin Light & Power Corporation, Fresno, made a trip to Chicago and New York a short while ago.

W. H. Hodge, manager of advertising and publicity, H. M. Byllesby & Company, recently spent a short time in San Francisco. While on the Pacific Coast he visited a number of the Byllesby properties.

F. N. Averill, of the Fobes Supply Company, Portland, Ore., left not long ago for New York by way of the Panama Canal. From there he will go to Hot Springs, Va., to attend the annual convention of the National Association of Electrical Supply Jobbers.

E. O. Howard was re-elected president and chairman of the board of directors of the Utah Light & Traction Company for the coming year at a recent meeting of the board of directors. **D. C. Green** was re-elected vice-president; **George B. Thomas**, secretary and treasurer, and **John F. Scheib**, assistant secretary and treasurer. The executive committee was retained as follows: **D. C. Green**, chairman; **E. O. Howard, David A. Smith, F. C. Schramm** and **J. M. Bidwell.**

W. R. Frampton, superintendent test department, Southern California Edison Company, was in San Diego recently and spent several days with the San Diego Consolidated Gas & Electric Company.

W. F. Raber, vice-president and general manager, San Diego Consolidated Gas & Electric Company, attended a meeting of the board of directors of the Standard Gas and Electric Company in Chicago a short while ago. En route Mr. Raber visited the Southern Colorado Power Company in Pueblo, of which he was general manager for several years.

O. B. Coldwell, vice-president and general manager, Portland Electric Power Company, Portland, has announced the following changes in the organization of the light and power department: **C. P. Osborne**, formerly superintendent, has been named general superintendent. **R. R. Robley**, formerly operating engineer, has been named superintendent of operation. **C. P. Dunn**, formerly designing engineer, has been promoted to chief engineer, with his duties expanded to include supervision of the testing engineer, right-of-way engineer and all assistant engineers, in addition to his former supervision of all the draftsmen and the engineers assigned to construction.

W. J. Dennis, assistant general manager, Northwestern Electric Company, Portland, recently spent two weeks in San Francisco and other California cities.

Leo M. Dunn and **J. L. Ray**, vice-president and manager of supply and equipment department, respectively, of the Graybar Electric Company, New York, lately made a business trip to the Pacific Coast, discussing with officials and managers of the Western Graybar branches the electrical supply business in the territories visited. While in San Francisco they attended a conference of managers and department heads of the Pacific Coast houses of the Graybar company in Seattle, Spokane, Tacoma, Portland, San Francisco, Oakland and Los Angeles. Others in attendance were **Messrs. Wallis, Berry, Colwell, Harper, Vandercook, Billica, Buttner, Brown, Todt, Nicoll, Bray, O'Reilly, Simmons, Crilly, Kelly, Ward** and **Carson.**

Theodore Settle of the General Electric Company, Ltd., London, recently spent a day in Spokane obtaining data on merchandising.

W. R. Matthews, district salesman for the Miller Lamp Company, paid a visit to Spokane recently.

Miss L. Carroll Dangler, home economist for the Edison Electric Appliance Company, spent six weeks in Spokane during the Hotpoint electric range campaign lately conducted there by The Washington Water Power Company.

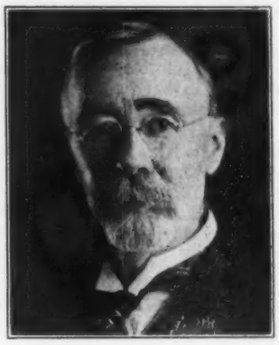
A. H. Jaeger, for the past several years manager appliance division of Edison Electric Appliance Company, Inc., Chicago, has joined the Leonard Refrigerator Company, a constituent company of the recently formed Electric Refrigerator Corporation. Mr. Jaeger will take charge of sales work in association with **F. A. Harvey**, vice-president of the Leonard company.

Louis Hausmann, formerly of the general engineering department of the South Philadelphia Works, Westinghouse Electric & Manufacturing Company, has been appointed a power engineer in the Chicago district office of the company.

Norwood W. Brockett, director of public relations of the Puget Sound Power & Light Company in Seattle, recently spoke before the Chamber of Commerce on the relation of electric power to industrial development.

E. E. Scofield has been made industrial engineer, and **A. H. Wegner** assistant industrial engineer for The Washington Water Power Company, Spokane.

Major Cooper Anderson, for the past fourteen years superintendent of power for the Utah Power & Light Company, Salt Lake City, has been appointed general superintendent of production and transmission of that company. This is a new position created as a result of the constantly increasing scope of the operations of the production and transmission departments. A consolidation of all activities of these departments has been effected, and the new superintendent will have complete supervision over them. Major Anderson's record of service with the Utah Power & Light Company and its predecessors extends over a period of twenty-six years, for it was on Feb. 1, 1900, that he accepted the position of general superintendent of the Telluride Power



MAJOR COOPER ANDERSON

Company's properties in Colorado. Prior to that he had spent twenty-two years in steam railroad work. In December, 1907, Major Anderson was promoted to the position of general superintendent of the Telluride Power Company's properties in Utah, with headquarters at Olmsted, Utah. Five years later when the Utah Power & Light Company acquired the properties of that company and various others he was appointed superintendent of power in charge of generation plants and high-voltage transmission and telephone lines in Utah and Idaho.

V. P. McNamara has been named resident manager of the Puget Sound Power & Light Company's electric service at Ellensburg, Wash. Mr. McNamara formerly was connected with the company in Everett.

W. B. Milliken, who has been connected with the Servel Corporation for some time, has been made manager for that company in the Rocky Mountain territory with headquarters in Denver, and a branch office in Salt Lake City. He will handle sales in New Mexico, Colorado, Wyoming, Montana and Utah.

L. R. Grime, formerly supply and lighting specialist with the Western Electric Company in Los Angeles, has been appointed district representative of the Graybar Electric Company in San Diego.

A. E. Bacon, who recently resigned from the Mine & Smelter Supply Company in Denver to become the representative of the National Metal Molding Company there, has opened offices at 922 Patterson Building in that city.

Harry J. Bauer, president of the Pacific Gasoline Company, Los Angeles, was elected a director of the Southern California Edison Company to fill the vacancy caused by the death of William E. Dunn. Mr. Bauer entered the employ of the company nineteen years ago as a junior clerk in the legal department at a salary of $25 per month, two years before his graduation from the law school of the University of Southern California, of which he is now a trustee. During the succeeding years he rose through the gradations of the legal department to the position of general counsel, retiring in 1919 to look after his own financial interests and organize them into the corporation of which he is now the head. For many years Mr. Bauer has been the close friend and associate of John B. Miller, president, and R. H. Ballard, vice-president and general manager, of the company, and of all the other officers and directors, and brings to the directorate an exact and intimate knowledge of its business, financial, and legal affairs. Mr. Bauer's election is in line with the long established policy of the Edison company in promoting to responsible positions and associating in its management those who have grown up with it and by their own initiative have developed the capacity for filling the most responsible positions of trust.

HARRY J. BAUER

Lee Moselle, for the past ten years chief clerk of the business agent, Bureau of Power and Light, Los Angeles, has resigned to become secretary of the City Club, Los Angeles. Mr. Moselle has been connected with first the Water Department and later the Bureau of Power and Light for the past nineteen years.

Jack Reinke of the Edison Lamp Works, not long ago gave the Electric Club of Seattle an illustrated talk on the manufacture of Mazda lamps.

A. C. Cornell, Robert Miller and **L. M. Cargo,** members of the advisory board of the Electrical League of Colorado, and **S. W. Bishop,** executive manager of the organization, attended the meeting of the Rocky Mountain Electrical Co-operative League in Salt Lake City a short time ago. Messrs. Cornell and Bishop were on the convention program.

David M. Roderick, for the past four years district representative in the Seattle territory for the Hoover Suction Sweeper Company, and for the past year president of the Electric Club of Seattle, has resigned his position to become general sales manager of Fuller Bros. & Company, Inc., with headquarters in New York City. He has been succeeded by **George L. Collier,** formerly Krantz safety-switch specialist with the Westinghouse Electric & Manufacturing Company. **Tom Wood,** vice-president of the Electric Club, will succeed Mr. Roderick as head of that body.

Bert Rowley, district manager of the Edison Electric Appliance Company, and **Lester Johnson,** district representative of the merchandise department of the General Electric Company, both with headquarters in Salt Lake City, attended the recent state-wide meeting of electrical men sponsored by the Electrical League of Colorado in Denver.

Ralph Cordiner, representing the Edison Electric Appliance Company, spent the week in Spokane not long ago.

R. B. Wooley, advertising manager, Savage Arms Corporation, Utica, N. Y., recently paid a visit to the Pacific Coast.

R. H. Ballard, executive vice-president and general manager, Southern California Edison Company, Los Angeles, was one of the speakers at the recent annual banquet of the Chamber of Mines and Oil in that city.

F. L. ReQua, formerly office manager, H. B. Squires Company, San Francisco, has resigned to become a member of the firm, Welding Service, Inc., of that city.

H. B. Betts, of Thomas & Betts, New York, has been visiting in Los Angeles with his local representative, the H. B. Squires Company.

A. H. Tracy, electrical engineer, Byllesby Engineering and Management Corporation, spent a few days with the San Diego Consolidated Gas & Electric Company not long ago. Mr. Tracy's itinerary included several Pacific Coast properties of the Byllesby chain.

L. A. Hobbs, Pacific Coast district manager, Edwin F. Guth Company, St. Louis, with headquarters in San Francisco, recently returned to that city after a trip to the company's home office. On his way back he stopped at Seattle, Portland and Vancouver.

R. W. Abright, city electrician of Long Beach, Calif., has been elected president of the Long Beach Electric Club. Mr. Abright has been a member of the electrical fraternity since 1904 when he entered the employ of the Southwest Engineering & Construction Company, Dallas, Texas. Three years later he became journeyman wireman in an electrical contracting shop. From 1911 to 1913, inclusive, he served as city electrical inspector for Dallas, and followed that by engaging in the electrical contracting business for two years. After the World War, in which he saw service overseas and was discharged from the army as first lieutenant in the Signal Corps, he again entered the electrical contracting business, this time in the oil fields at Wichita Falls, Texas. Then he went to Long Beach where for two years he was affiliated with the electrical contracting firm of Ward Akley, Inc., finally becoming city electrician, a position he has held for the last three years. Mr. Abright has been president of the California Association of Electrical Inspectors for the past year.

R. W. ABRIGHT

C. B. Hall, president of the Illinois Electric Company, Los Angeles, recently returned from an extensive business trip through the East. Mr. Hall went and returned by way of the Panama Canal.

Harry Harper, manager of the Graybar Electric Company, Los Angeles, was a recent business visitor to San Francisco.

Elbert Kramer, until recently in charge of sales of Universal appliances in the Northwest territory for Landers, Frary & Clark, New Britain, Conn., has been appointed manager of the range and appliance department for Listenwalter & Gough, Inc., Los Angeles.

Obituary

Delbert A. Haase, district line maintenance supervisor of the Puget Sound Power & Light Company at South Cle Elum, Wash., was killed instantly on March 29 when he was crushed beneath a pile of cedar poles he was supervising unloading in South Cle Elum.

TRADE NOTES

Beaver Machine & Tool Company, Inc., Newark, N. J., has issued recently a new 20-page catalog, covering its entire line of products. Descriptions of heater plugs, switch plugs, attachment plugs, switches, sockets, receptacles, are given as well as photographic illustrations. Detailed price lists also are included in the catalog.

The Robert June Engineering Management Organization, Detroit, has moved to larger quarters at 2208 West Grand Boulevard, where it now occupies the entire building. This is the company's fourth move in four years to larger quarters. The new building will give it greatly added facilities for serving its clients.

The Okonite Company, Passaic, N. J., has issued recently a series of folders descriptive of its products. The folders are produced in bright colors with catchy covers to attract the eye. Copies can be had by addressing the company.

Hobart Brothers Company, Troy, Ohio, has produced the new HB high-rate battery tester, which is designed to test all three cells of a battery without removing it from the car. The carbon pile rheostat, with ammeter calibrated 300-0-300 and the three voltmeters calibrated 3-0-3, make it possible to test all three cells at the same time under discharge conditions such as exist when the car is actually in use.

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has issued a special publication No. 1643-A describing the application of oil circuit breakers. It covers fully the general application of oil circuit breakers, the determination of short circuit current, and the precautions necessary, and devotes a number of pages to tables and charts.

Curtis Lighting, Inc., Chicago, has issued a set of architects' detail plates showing methods of church lighting, gymnasium lighting and concealed lighting effects in legislative chambers of the House of Parliament, Ottawa.

Ohio Brass Company, Mansfield, Ohio, has produced a new O-B copper arc weld bond with terminals which retain and support the deposited metal. This new product is known as the Titon bond.

Pass & Seymour, Inc., Syracuse, N. Y., has produced a new canpoy switch known as P&S 3310. Various types of wall brackets may be used with this new supporting switch from the flat back to the deep embossed plate, where the proper outlet box is installed.

The Swartzbaugh Manufacturing Company, Toledo, Ohio, has developed a two-heat combination electric cooker, thermal jug, ice cream freezer and fireless cooker, known as EC Jr.-10.

The Graybar Electric Company recently opened offices in San Diego, with **L. R. Grime** as district representative. Mr. Grime was for six years with the Western Electric Company in Los Angeles, in the capacity of supply and lighting specialist.

J. G. Pomeroy Company, formerly at 51 Federal Street, San Francisco, has moved into its new building at 960 Folsom Street.

The Torrington Company, Torrington, Conn., has issued a new catalog on ball bearings, which gives complete details of the entire line of open (magneto) and closed (radial) types of ball bearings, which range in shaft size from 4 m/m (.1575) to 25 m/m (.9842). Another publication entitled "Romance of Needle in Little Torrington" has been printed in booklet form.

Truscon Steel Company, Youngstown, Ohio, has issued a folder descriptive of its steel poles, pointing out their economy, permanence and safety advantages. Photographic illustrations are included in the folder.

The Rix Company, Inc., with offices in San Francisco and Los Angeles, has issued bulletin P.C. 103, describing its portable air compressors. The bulletin is illustrated and gives complete specifications.

Fairbanks, Morse & Company, Chicago, have introduced a new improvement in motor lubrication in the furnishing of proper greases in collapsible tubes, each containing just enough grease for a motor's annual requirements. After flushing out the old grease with kerosene as directed in printed instructions supplied with the tube, the new FMCO grease is squeezed from the grease tube directly into the bearing. Four sizes of tubes are available for corresponding sizes of bearings.

Roach Appleton Manufacturing Company, Chicago, has appointed **George A. Kieffer,** 141 Fremont Street, San Francisco, as representative of its line of wiring supplies for the northern California territory. Mr. Kieffer will maintain warehouse stock in San Francisco. The company also has appointed the **Wesco Company,** Seventh and Lawrence Streets, Denver, as representative for the Rocky Mountain region. Warehouse stocks also will be kept in Denver. **Walter G. Michel,** 312 Omar Avenue, Los Angeles, is the Coast representative in southern California.

The Quigley Furnace Specialties Company, New York, has issued a booklet describing the Quigley refractory gun for quick repairs and maintenance of furnace linings, including hot patching and surface coating.

Uehling Instrument Company, Paterson, N. J., is distributing a new catalog No. 150, covering its combined barometer and vacuum recorder for use with steam turbines. This instrument records the absolute back pressure of the turbine exhaust. High accuracy is claimed for the instrument because of the mercury column principle employed.

Collyer Insulated Wire Company, Pawtucket, R. I., has issued a small folder illustrating and describing its different types of covered wires.

Mutual Electric & Machine Company, Detroit, has produced a new product known as the "Bull Dog" Saftofuse, which represents a new departure in "safe switching and safe fusing," with a capacity of 30-amp. and 60-amp., 250 volts. Bulletins No. 102, 103 and 104, describing this material and their application are now available.

The Ludlum Steel Company, Watervliet, N. Y., is enlarging and rebuilding one of the ingot heating furnaces for its 18-in. mill. This will result in a greatly increased output from this mill.

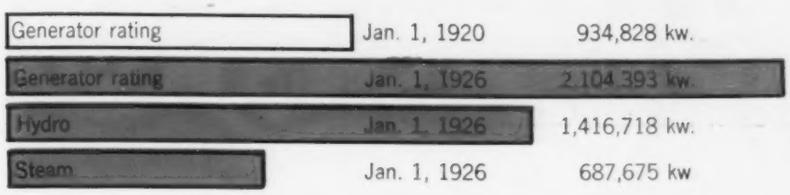
Quienes son estos caballeros? With the exception of H. C. Rice, who is assistant manager of the merchandising department of the Southern California Edison Company, the entire group is made up of representatives of the Frigidaire sales organization of southern California, all headed for the tenth annual Frigidaire convention at Dayton, Ohio, April 8 and 9. Left to right—Ivan De Joung, Jacques Tyrol, T. J. McIntire, J. M. Hull, W. A. Drann, H. C. Rice, G. E. Tabor (over the rail), Roy C. Miller (in back), H. S. Jordan, Herbert Bell, Earl Myers and George H. Ratterman and Sam Fingerhut (on step).

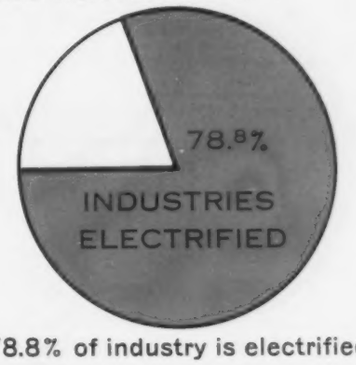
Load Building *Plus* Industry Building

By and with the Power Companies of the *Pacific Coast Electrical Association*

Electrical development has become the index of community growth and industrial progress. This is due primarily to the initiative of the central stations in bringing about a close study of the problems involved, the development of new apparatus and practices, preparation for the future, and the establishment of public relations by which the public is participating as partners in power development as a community enterprise. These conditions are a consequence of the close co-operation of member companies of the Pacific Coast Electrical Association.

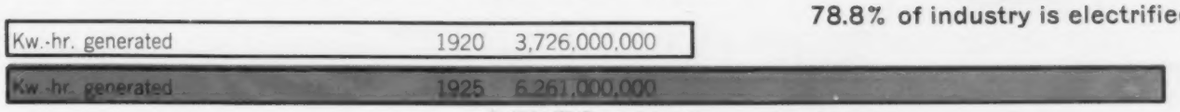
Generator rating during the period Jan. 1, 1920 to Jan. 1, 1926 has increased 125%.


Generator rating Jan. 1, 1920 934,828 kw.
Generator rating Jan. 1, 1926 2,104,393 kw.
Hydro Jan. 1, 1926 1,416,718 kw.
Steam Jan. 1, 1926 687,675 kw

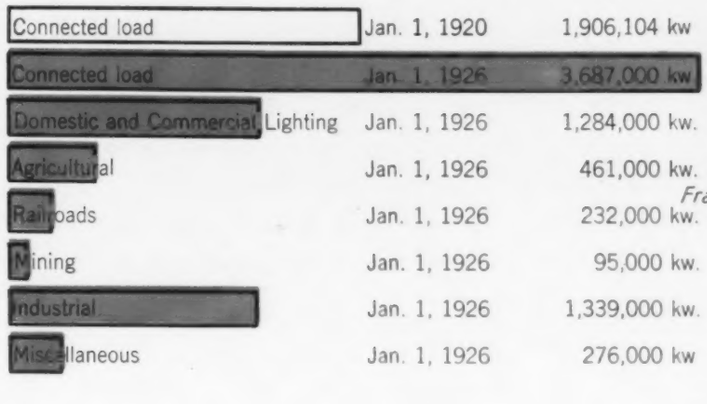


78.8% of industry is electrified

A 70% increase has been made in the yearly kw.-hr. generation during the period Jan. 1, 1920 to Jan. 1, 1926.



Connected load during the six years has increased by 1,780,896 kw.

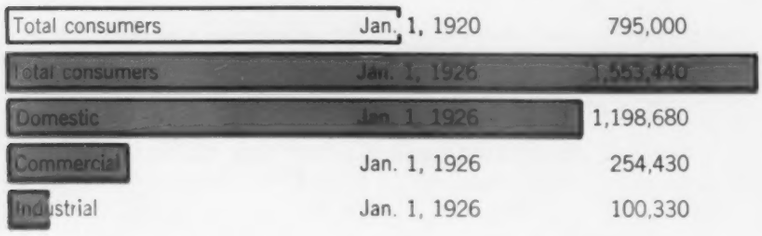

Connected load Jan. 1, 1920 1,906,104 kw
Connected load Jan. 1, 1926 3,687,000 kw
Domestic and Commercial Lighting Jan. 1, 1926 1,284,000 kw.
Agricultural Jan. 1, 1926 461,000 kw.
Railroads Jan. 1, 1926 232,000 kw.
Mining Jan. 1, 1926 95,000 kw.
Industrial Jan. 1, 1926 1,339,000 kw.
Miscellaneous Jan. 1, 1926 276,000 kw

The territory of the P. C. E. A.

The Growth of General Building and Construction

The Outlook for Electrical Appliance Sales in the Territory of the *Pacific Coast Electrical Association*

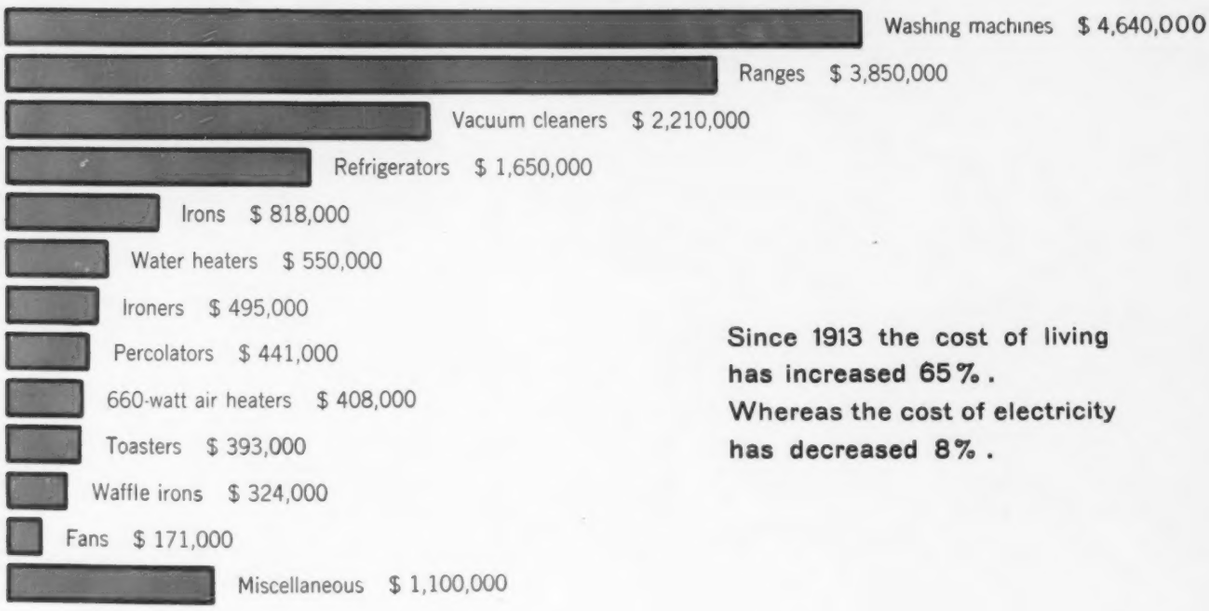
Consumers numbering 758,440 have been added to the lines of the central stations in the P. C. E. A. territory from Jan. 1, 1920 to Jan. 1, 1926


Total consumers Jan. 1, 1920 795,000
Total consumers Jan. 1, 1926 1,553,440
Domestic Jan. 1, 1926 1,198,680
Commercial Jan. 1, 1926 254,430
Industrial Jan. 1, 1926 100,330

88% of all homes are wired

Building permits in 1925, for 13 of the principal cities in the P. C. E. A. territory, were $ 188,606,502 greater than in 1920

In no section of the country is greater use being made of electric service by the domestic consumer. During 1926 it is estimated that over $ 17,000,000 will be spent by consumers in these three states for electric labor saving household devices. This will be divided substantially as follows:-



Since 1913 the cost of living has increased 65%. Whereas the cost of electricity has decreased 8%.